The Glass Industry

PUBLISHED MONTHLY AT NEW YORK

Copyright, 1921, by Glass Industry Publishing Company, Inc.
Vol. 2. APRIL, 1921 No. 4

The Composition of Opaque Glasses

By J. B. KRAK

(*Written for* THE GLASS INDUSTRY)

The use of electricity for illuminating purposes has been directly responsible for the remarkable development of a comparatively new but already extremely important branch of the glass industry. In order to protect the eyes from the intensity of electric light rays it became desirable to enclose the source of light, wholly or in part, by a glass which would completely diffuse the direct and powerful beams of light, absorb as little luminosity as possible and, in some cases, possess considerable power of reflection. The latter property became desirable when lights were suspended in bowls made of translucent glass which has the power to reflect a large portion of the light against the ceiling of the room or hall, or sometimes against adjacent walls. The results obtained by the industry in response to the demands of illuminating engineers speak for themselves. They display a resourcefulness and adaptability on the part of manufacturers which is unsurpassed in any other line of the glass industry, and the beauty of design of some of their products rival the best examples of purely decorative glass ware.

A ray of light, on striking a glass surface, penetrates the glass, is partly absorbed and partly reflected. If the glass contains a large number of minute particles which have optical properties different from the main body of glass, the light is reflected in all directions and becomes diffused. The particles may be as transparent as the glass medium which carries them, yet they create the impression on the eye of being white, for the same reason that snow appears to be white. Snow, as it is known, consists of perfectly transparent, colorless crystals, as clear as the pure water from which they have congealed. The white color is caused by the reflection and diffusion of light by the innumerable crystal faces. The colorless particles imbedded in glass have a similar effect.

Opacity may be obtained in many ways and through the use of a variety of substances which enable the glassmaker to obtain almost any degree of opaqueness desired, from a dense opal to semi-transparent glass. Substances used to produce opacity include magnesium silicate, such as talcum and asbestos; phosphates, such as bone ash, calcined guano and sodium phosphate; fluorides, such as sodium fluoride, calcium fluoride, lepidolite, cryolite and fluosilicates. Fluorides are nearly always used in conjunction with aluminum compounds, such as feldspar, china clay, hydrate of alumina or aluminum oxide. Other substances, used occasionally, are tin oxide, titanium oxide and zirconium oxide. All the substances mentioned, under proper conditions, are opacifiers. Their action can be modified by the use of a series of substances which alone would produce slight, if any, cloudiness in glass. Such substances include common salt, borax, arsenic, antimony and sulphates of sodium, calcium, barium, strontium and magnesium.

ALABASTER GLASSES

Probably the oldest opaque glasses belonged to the class of alabaster or alba glasses, which name is applied because of the resemblance to the mineral gypsum. Natural alabaster has the composition $CaSO_4 2H_2O$, and is semi-translucent. It is compact and fine grained, and suitable for carving. Alabaster glass is used especially for the manufacture of vases, jars and perfumery bottles. It was first made in Bohemia.

The earliest type of alabaster glass was high in silica and low in lime. It was made at a low temperature and the opacity was, without doubt, due to devitrification. Reaumur's porcelain belongs to this class. It was made with potash. The presence of soda often caused revitrification of the glass, which also occurred when the temperature was allowed to become too high. Devitrification was sometimes induced by the use of talcum or asbestos. According to a method used in Europe, clear glass was melted and slowly poured into cold water, forming a mass permeated with cracks. The glass was broken up and added to another pot filled with transparent glass of similar composition. The mixture was kept at the lowest possible temperature needed to keep the glass in a workable condition. The opacity thus obtained may be explained by assuming that the numerous fragments of glass form centers from which crystallization can proceed, which in a short time pervades the entire mass. The opinion

has been expressed that this method of working introduces countless air bubbles in the glass which cannot escape through the high viscosity due to the low temperature at which the glass is kept. The bubbles are believed to produce opacity by scattering the light. The following analyses show the composition of the older types of alabaster glasses:

Analyst	Peligot[1] Per Cent	Stein[2] Per Cent	Stolba[3] Per Cent	Krak Per Cent
Silica .....(SiO_2)	80.90	79.51	82.30	71.81
Alumina .....(Al_2O_3)	0.80	....	3.20	2.99
Lime .....(CaO)	0.70	2.79	3.30	1.78
Magnesia .....(MgO)	....	....	....	0.48
Sodium Oxide (Na_2O)	....	....	5.60	6.15
Potassium oxide(K_2O)	17.60	16.87	5.66	15.02
Sulphate .....(SO_3)	....	....	....	0.55
Chloride .....(Cl)	....	....	....	0.04
Phosphoric acid (P_2O_5)	....	....	....	1.13
Lead oxide.....(PbO)	....	1.00	....	....

PHOSPHATE GLASSES

With the improvement of the heating systems it became difficult to make alabaster glasses and means were sought to produce opacity which would be more permanent. This was done by introducing bone ash, the use of which has been ascribed to Kunckel, who recommended the following batch:[4]

Sand	60 lbs.
Carbonate of potash	40 "
Bone ash	10 "

Bone ash is produced in large quantities in the manufacture of meat extract. It contains about 80 per cent phosphate of lime, 3 per cent magnesium phosphate, 4 per cent calcium fluorides and 10 per cent carbonate of lime. Fluorine, therefore, if unknowingly, has been used at an early date. Calcined guano can also be used. The guano richest in phosphoric acid comes from Baker Island in the Pacific and consists, like Peruvian guano, of a partly mineralized mass composed essentially of lime-phosphate, 78 per cent, and magnesium phosphate, 6 per cent. Baker guano contains only traces of iron, and for this reason is preferred to all others. Microscopic examination of bone ash and calcined guano reveals the presence of very minute crystals which are loosely held together. On account of the extremely fine state of division, these substances dissolve easily in molten glass. In order to obtain an even degree of opacity the bone ash should be carefully mixed with the other ingredients of the batch. In recent years sodium phosphate and precipitated calcium phosphate are being used. These substances can be manufactured in a very pure condition which enables the glassmaker to obtain uniform and dependable results.

In the liquid condition, phosphate glass appears to be clear and transparent as common glass. Only in the transition into the rigid condition does it become opaque. If small amounts of phosphate are used, an opalescent glass is produced. The opacity increases in proportion to the quantity of phosphate added to the batch, and is also intensified by repeated heating and cooling. The amount of phosphate required to produce a certain degree of opacity varies with the composition of the glass. A low silica glass needs less phosphate than glasses higher in silica to obtain the same effect.

Some investigators assume that the phosphates of lime and magnesia are soluble in liquid glass at high temperatures and that these compounds crystallize out on cooling. Scharrer[5] is of the opinion that the opacity of this type of glass is not due to devitrification but to the fact that calcium phosphate and glass, at high temperatures, are perfectly miscible liquids, such as water and alcohol. It is assumed that at lower temperatures this property is lost and that the liquids become immiscible such as water and oil. As the difference in density of the two liquids is slight, and on account of the viscosity, a separation into two separate layers cannot take place but the glass becomes permeated with minute bubbles of calcium phosphate, which form an emulsion. In this condition the glass becomes rigid. Microscopic examination shows countless small drops, which are believed to be calcium phosphate.

The white color of phosphate glass may be so dense that a black object cannot be seen through it. An electric light, however, penetrates the glass in such a way that it appears as a red spot in which the filament may be visible. This is known as fire, and is considered objectionable. To obviate this trouble, tin oxide is sometimes added to the batch, which renders the glass densely white but seriously impairs the transparency.

On treatment of finely ground phosphate glass with dilute nitric acid, calcium phosphate goes in solution, which proves that it is present as such in the glass and not in the form of a complex substance.

FLUORIDE GLASSES

About 1860 the cryolite glass industry began to develop. It had been known for some time that this material produces opacity, but until the Greenland deposits were discovered it was too expensive for general use. It was first used on a large scale by the Hot Cast Porcelain Company of Philadelphia and Pittsburgh, which used batches of the following composition:[6]

Sand	100 lbs.	Sand	100 lbs.
Cryolite	40 "	Cryolite	20 "
Zinc oxide	90 "	Nitrate of soda	12 "
		Nitre	4 "
		Lead oxide	2 "

Cryolite ($Na_6Al_2F_{12}$), a mineral of the order of double fluorides, occurs in nature as large, massive deposits. In Greenland it is found in beds up to eight feet thick. It is white and translucent and has the lustre of glass. This material clouds glass in consequence of its fluorine and aluminum contents. The sodium therein acts as a flux. When cryolite is used alone it corrodes the walls of the pots in a short time by gradually dissolving the inner surface. In order to correct this tendency the fluorine is neutralized by the admixture of feldspar and alumina.

In later years, the cost of cryolite was increased to about ten times its previous price by a Danish concern which had obtained control of the deposits. The high cost made it desirable to obtain a substitute, which was found in the use of

[1]Annales du Conservatoire (4) 2, 536.
[2]Wagner's Jahresber., 16, 279.
[3]Polyt. Centralblatt. 1858, 150.
[4]Ars Vitraria, 1743
[5]Abegg. Handbuch der anorg. Chemie, III, 2, 391.
[6]Dingler's polyt. Journal, 213, 221.

feldspar and fluorspar. Both minerals occur in large quantities, but often contain a considerable percentage of iron, so that only selected material can be used. Fluorspar contains about 52 per cent lime and 48 per cent fluorine. The composition of feldspar varies greatly. It is essentially an aluminum silicate, containing also sodium and potassium. Although by careful calculation a glass can be obtained which resembles cryolite glass in composition, a mixture of feldspar and fluorspar is not as effective as a correspondingly quantity of cryolite. Sometimes it is more convenient to add alumina in the form of the oxide or hydroxide. This is done to avoid the increase of the silica contents due to the large amount of this element in feldspar. Instead of fluorspar, sodium fluoride is sometimes used to avoid the introduction of large amounts of calcium, which makes the glass brittle and difficult to work. Good results are obtained by using a mixture of cryolite, fluorspar, alumina and feldspar. Some manufacturers, however, prefer to pay the high price of cryolite rather than use any other fluorine compound. They find that the quality and uniformity of the product more than compensates for the higher costs.

An admixture of lead oxide lends the glass a beautiful lustre, which cannot be obtained in any other way.* With the object of changing the softening point and viscosity, varying amounts of borax are used. Lead oxide may be replaced, wholly or in part, by zinc oxide. To lower the softening point a mixture of soda and potash may be used, instead of either one alone. Nitre, arsenic or antimony are recommended as purifiers, the latter two also as opacifiers. Manganese and powdered blue are used to correct the color. While nearly all agree on essentials, there is abundant room for individual preferences, and it is safe to say that scarcely two factories could be found where identical mixtures are used.

It has been known for some time that the presence of certain amounts of sulphate or chloride increase the opacity. Cauwood and Turner[7] found that these substances induce cloudiness in clear glasses. They were formerly introduced as impurities of the ingredients of the batch. At the present time they are purposely added, sulphates in the form of gypsum, barium sulphate, salt cake or strontium sulphate, chlorides as common salt.

CAUSES OF OPACITY

No certainty has been established as to the causes of opacity of fluoride glasses. The methods of microscopic examination which have been applied with success to study the phenomena of devitrification, have failed to disclose the reasons why opalization occurs. Various investigators have ascribed it to crystalline alumina, sodium fluosilicate, aluminum fluoride, zinc or lead fluoride, silica in finely divided form, silicon fluoride in gaseous or in crystalline form or to the presence of microscopic bubbles in the glass. An explanation which deserves consideration is given by Smull[8] who believes that opacity is due to the existence in the glass of very finely divided substances of unknown composition in a condition ordinarily described as colloidal. If alumina or silica, or any other oxide is held in very fine suspension in glass, they may be considered in the same manner as a pigment and a vehicle with respect to hiding power. Good hiding power is obtained when the refractive indices of the pigment and the oil are materially different. Smull considers opaque glasses as consisting of a glass medium, corresponding to the vehicle, and the finely divided particles, in colloidal suspension corresponding to the pigment.

Silverman[9] has found that sulphates and chlorides are necessary to induce precipitation of colloidal suspensions and claims that the bivalent sulphate ion produces more intense whiteness than the monovalent chloride.

Definite knowledge of the causes of opacity is of great practical importance. It will tend to eliminate from many batches now in use substances which are either superfluous or even detrimental to good results. It will simplify the composition of the batch and will enable the glass manufacturer to make such adjustments as his working conditions and his product may require, with an element of certainty lacking at the present time. A solution of this problem is urgently desired.

PATENTS

The composition of some opaque glasses has been patented U. S. Patent No. 1,097,600, issued to George Macbeth, describes the composition of

> "A batch which will produce a snow white glass, which is not clear but which is translucent to a high degree and will transmit light without the reddish or yellow color known as fire . . . with such light diffused in a pleasing manner restful to the eyes and with a minimum loss of illuminating power."

The batch is composed as follows: Sand 100 lbs., lead oxide 15⅝ lbs., soda 21⅞ lbs., nitre 5½ lbs., salt 5½ lbs., borax 1½-2½ lbs. To the foregoing batch are added 18.12 lbs. of hydrate of aluminum ($Al_2H_6O_6$) containing about 11.84 lbs. of oxide of alumina (Al_2O_3) and six pounds of fluorspar (CaF_2).

U. S. Patent No. 1,143,788, issued to Henry A. Schnellbach, covers a batch of the following specifications: Sand 345.8 lbs., litharge 56.8 lbs., soda 86.4 lbs., cryolite 20 lbs., aluminum oxide 60 lbs., nitre 32 lbs., borax 8 lbs., plaster of Paris 5 lbs.

> "These ingredients . . . are heated until entirely fused with the result that they produce a glass that is translucent, opaque and free from specks, a glass which when pressed into proper shapes for use with electricity or gas light has more than ordinary powers for reflecting and diffusing and at the same time absorbing, but very little of the light that is used."

The inventor claims the discovery that

> "cryolite, aluminum oxide and plaster of Paris have the effect of clouding or rendering translucent and at the same time opaque the ordinary crystal glass which would result from the mixing of the other ingredients of the batch. As the aluminum, fluorine and sulfur are the coloring and opacifying agents, other compounds containing them may be substituted, provided an adjustment be made to secure the proper amount of said elements as heretofore set forth. The amount of the opacifying agents may also be varied depending on the opacity desired."

[7] Journal Soc. Glass Techn. 1, 87.
[8] Jl. Soc. Chem., Ind. 34, 405.
[9] J. Ind. Eng. Chem. 9, 33.

No reducing agent, capable of deoxidizing the sulphate is present in the batch.

U. S. Patent No. 1,245,487, granted to Joseph J. Miller, contains sodium fluoride and strontium sulphate. The composition of the batch is as follows: Sand 100 lbs., soda ash 49 lbs., red lead 56 lbs., feldspar 120 lbs., sodium fluoride 7½ lbs., strontium sulphate 1¾ lbs., sodium chloride 5 lbs., alumina 22½ lbs., nitre 5 lbs., antimonious oxide ½ lb.

U. S. Patent No. 1,166,922, issued to James O. Meara, covers a batch which is free from fluorine and which yields a glass without any reddish fire. The patentee states that:

> "In practice I have found that good results are obtained in a furnace working at a temperature of approximately between 2,500 and 3,000 degrees F. and the length of time of the operation generally required is from twenty-one to twenty-four hours. The ingredients from which the batch is composed are the following, combined in substantially the proportion stated: sand 100 lbs., alumina 30 lbs., oxide of lead 22 lbs., silex 12 lbs., soda ash 37 lbs., borax 6 lbs., arsenious oxide 3 lbs., antimony oxide 1¼ lbs., common salt 1½ lbs., salt cake 1½ lbs., crystallized Glauber's salt 2 lbs., gypsum 2 lbs. Said ingredients are fused in any suitable manner, and form, when so combined, a white translucent glass which transmits, when formed into a sheet, globe or shade, light of a white color and free from yellow, red or opalescent rays. The heating operation is stopped before the glass returns to a clear glass stage and when the specks in the glass are substantially eliminated."

The glass is described as "opaque semi-translucent glass."

Henry C. Stiefel obtained U. S. Patent No. 1,153,353 covering a batch for

> "Semi-opaque semi-translucent glass, one of whose ingredients is nitrate of lime in combination with phosphate of magnesia and additional ingredients, comparatively inert, and neutral to the foregoing ingredients which upon fusion evolve gases which in passing off keep the batch, when in fused condition, in a condition of ebullition."

The batch is composed as follows: Sand 100 lbs., soda ash 15 lbs., lead oxide 15 lbs., calcium nitrate 3½ lbs., magnesium phosphate 3½ lbs., magnesium carbonate 3½ lbs., alum 3½ lbs.

That possession of these, or any other patents of this character will enable the holder to obtain a monopoly of the manufacture of this type of glassware must be considered very doubtful. Batch formulae for alabaster, opal and various kinds of semi-translucent glasses have been common property for many years and antedate any patents issued. It would appear to the mind not trained in the finesse of patent-law procedure that the rights granted to the inventors mentioned above infringe on one another in several points. As a matter of fact, some have been declared invalid by the courts. So far, interference procedures have served to little purpose, but they have resulted in considerable expense and worry to a number of concerns whose right to make opaque glass has been challenged by financially powerful corporations in an endeavor to obtain control of this branch of glass manufacture.

Prevents Coalescence of Water on Glass

A coating to be applied to glass to prevent drops of water from forming on its surface has been patented by F. G. Fully (U. S. 1,344,686). The mixture consists of corn syrup, 66 parts; H_2O, 33 parts; $NaHCO_3$, 0.1 part; cinnamon, 0.9 part.

Milk or Alabaster Glass

By ASHER BLUM*

(*Written for* THE GLASS INDUSTRY)

For many years inventors in the glass industry have devoted their attention to the manufacture of the so-called milk or alabaster glass which would cause a uniform, white, diffused light to be transmitted, instead of the unpleasant glare arising when ordinary transparent glass is used.

In U. S. Patent No. 210,331 issued on November 26, 1878, to Kempner, the inventor combined with the ordinary glass materials such as soda, potash and sand, a mixture consisting of feldspar, fluorspar and heavy spar. He also stated that witherite could be substituted for the heavy spar. The inventor stated that the heavy spar (barium sulphate) would increase the density and polish of the glass and that glass produced from the ingredients above described, would possess the required milky appearance and would not require any rewarming when it was molded or manipulated in any other manner as it cooled or set less rapidly than the ordinary glass.

In British Patent No. 983 of 1866, Johnson proposed to obtain a glass of this character from the following ingredients:

Double fluoride of aluminum and sodium, pearlash or soda, sand, chalk, saltpetre and oxide of manganese.

Kempner also secured a British Patent No. 3,727 of 1878 similar to his U. S. Patent before mentioned.

In German Patent No. 31,112, dated April 29, 1885, it was proposed to add alkali fluorides to the glass mixture and clay could also be added.

In German Patent No. 33,425, dated May 7, 1885, it was proposed to use acid alkali fluorides instead of the alkali fluorides mentioned in German Patent No. 33,112.

In German Patent No. 69,979, dated August 30, 1893. it was stated that milk glass to which cryolite or other fluorides had been added, together with clay, became opaque after a short time, especially after heating. To prevent this, aluminum and carbon or carbon producing substances were added to the glass and this precaution also conserved the pots.

In German Patent No. 165,986 to Kempner, dated January 31, 1906, it was proposed to make a milk glass out of sand, soda and feldspar poor in lime and sodium fluosilicate.

U. S. Patent No. 777,334 corresponds to this German patent. This inventor had previously secured U. S. Patent No. 468,723 for producing a clear, white glass by using an alkaline silicofluoride.

In U. S. Patent No. 1,097,600, owned by the Macbeth Evans Glass Company, it was proposed to add oxide of aluminum and fluorspar to the ordinary ingredients for making glass. The patent states that the use of oxide of aluminum together with the fluoride apparently produces tiny specks throughout the glass, which diffused or scattered the light and gave the glass its white appearance.

In U. S. Patent No. 332,294, dated December 15, 1885, it is stated that it was already well known at that time to use fluorspar and feldspar for producing so-called opal glass.

In British Patent No. 2,342 of 1880 it is stated that a

*Of Mock & Blum, patent attorneys.

milky appearance can be produced in glass by adding arsenic or tin peroxide or antimonic acid.

In British Patent No. 3,147 of 1882 it is stated that calcium phosphate could be used for this purpose.

In British Patent No. 6,889 of 1884 it was stated that cryolite and the like could be replaced by an alkaline fluoride together with kaolin.

In British Patent No. 2,626 of 1890 it was stated that the silicofluorides of alkalies should be added to any glass batch. This patent suggests a mixture of sodium carbonate, chalk, sand, kaolin and sodium silicofluoride.

In U. S. Patent No. 1,192,048, owned by the Macbeth-Evans Glass Company, it is stated that a sulphate such as aluminum sulphate and a fluorine compound such as feldspar or cryolite should be added to the ordinary glass mixture.

In U. S. Patent No. 1,214,202, owned by the Macbeth-Evans Glass Company, it is stated that aluminum hydrate, fluorspar and sodium silicofluoride should be used.

In U. S. Patent No. 1,245,487 it is stated that two aluminum compounds such as feldspar and alumina, sodium fluoride and salt and strontium sulphate be added.

It is thus evident that a large variety of formulas has been developed, since the earlier patents appeared upon this subject, and that quite a number of these formulas are based upon patents which have expired and which are therefore open to free public use.

It is to be noted in this connection that all patents taken out in foreign countries are free to public use in the United States unless a corresponding U. S. patent has been issued thereon to the foreign inventor and that any U. S. patent more than seventeen years old is open free to public use unless an extension thereof has been secured.

As an extension of a U. S. patent can only be secured at the present time by a special act of Congress, such extensions are practically unknown, and it is substantially safe to assume that any U. S. patent more than seventeen years old has expired and has become public property.

The Manufacture of Iridescent Glass*

Translated for THE GLASS INDUSTRY

Recently iridescent glass for decorative purposes has once more come into wide use. Since the first samples were exhibited at the Universal Exposition at Vienna, the method of manufacturing this kind of glass has undergone many changes and improvements. The first experiments were made in a very primitive way by an open fire in a blacksmith shop and no one could have foreseen how the process was to be developed in such a practical form that it would eventually become a specialized branch of glass decoration.

It had been observed long ago that atmospheric influences cause the surface of glass to become iridescent. In 1873 glassworkers of Zlatno found that glass made in the presence of burning fireworks showed iridescence and this observation was studied for the purpose of developing it into a method of decoration. The process was worked out most successfully in Bohemia where the glass industry has flourished for centuries.

Iridescence can be obtained in two ways, namely, by the wet and the dry processes. Glass surfaces, treated with certain chemicals, become decomposed and what might be termed devitrification sets in, which produces many beautiful colors. The dry process is the most widely used because the method is both rational and simple. The glass objects are heated in a muffle and exposed to vapors of metallic salts, until the desired effect is produced. Usually chloride of tin, or tin salt is used, mixed with barium carbonate, strontium carbonate and strontium nitrate. To obtain ordinary iridescence a mixture of tin salt, barium carbonate, strontium nitrate and copper nitrate is used. Since many metallic salts attract moisture from the atmosphere, the material should be kept in tightly closed containers.

The oven used for this work consists of two parts. In one section the glass is heated. The second part is horizontally subdivided in two divisions. The lower one contains an iron vessel, holding the metallic salts; the upper part has a muffle with two openings, located in such a manner that the vapors of the metallic salts enter through one opening and leave through the other. It is obvious that there should be a strong draft to carry off vapors which are injurious to health. The glass objects are warmed slowly to a red heat. It is important that the heating process be gradual, for otherwise the iridescence becomes irregular. If the oven shows unequal temperatures, the objects should be turned frequently to obtain an even heating effect. Drafts inside of the oven should be avoided, otherwise the iridescence becomes cloudy and mottled. The production of pure colors requires not only practical experience, but also constant attention. The composition of the glass plays an important part. Glasses rich in lead show better results than hard glasses, high in silica.

In Bohemia iridescence of glass is obtained with tin salt only. If, however, more brilliant tones are desired some barium nitrate is added. Strontium brings out the red colors, barium the blue and tin the opalescent and bluish white tints. If arsenic is added, the colors become more subdued. The degree of heat and the time of exposure to the vapors plays an important part in the intensity of individual colors. For this reason it is advisable to make preliminary experiments with broken glass.

To obtain iridescence of glass beads and small objects a sieve is used. The objects are first heated and exposed to vapors of metallic salts, passing through the sieve. Iridescent window glass may be produced by treatment with a mixture of ammonium-tin chloride and finely divided sawdust or pulverized clay, applied immediately after the glass has been flattened. If iridescent glass is overheated, the colors become subdued and the glass looks as if attacked by atmospheric influences and antique. If a mixed effect of

*Otto Wilhelm in Diamant, v. 42, p. 601-2 and p. 619-20.

brilliant and fainter colors is desired, certain places are covered. In this way a radiation effect can be obtained.

Iridescence by the wet process is accomplished as follows: Glass of a certain composition is partly covered with a design of wax and immersed in 20 per cent hydrochloric acid at 120° Centrigrade under a pressure of five atmospheres. The glass takes on an appearance as if it had been buried for a long period in wet earth, and the surface is iridescent. The process is not simple; much depends on the properties and composition of the glass. Soft, easily decomposable glass is the most suitable. For this reason lead and soda glasses give the best results. It is advisable to make preliminary tests with broken glass. Special designs can be obtained by covering certain parts. Iridescent glass should be cooled slowly and all grease and moisture should be carefully removed as soon as possible after completion.

The Modern Gas Producer

By JULIUS BEEMAN*

(*Written for* THE GLASS INDUSTRY)

This article presents certain information in a condensed form for those who do not care to go into a detailed history of the art.

As practically all gas producers used in the iron, steel, glass and ceramic industries are of the steam blown continuous type, no reference will be made to any other.

Whether hand-poked or stoked, semi-mechanical or full mechanical, the actual process of gas making is the same, and for convenient reference we divide the interior of the producer into zones, air and steam being introduced under pressure through annular or jet type blowers into the lowest, or ash zone. The ashes serve to protect the grates and to diffuse and preheat the incoming air and steam in combination. Combustion takes place immediately above the ash zone and here the heat required in gasification is generated, the carbon in the coal being reduced to carbon dioxide, commonly referred to as CO^2. When considered separately this is referred to as the combustion zone. Almost co-existent with this zone and immediately above it is the decomposition zone in which the steam from the blast and the carbon dioxide are decomposed into hydrogen and carbon monoxide, or CO. To bring about the necessary reactions it is essential that this zone be kept at a temperature in excess of 1800° Fahr. The uppermost zone is referred to as the distillation or green coal zone and here the freshly added fuel is partially distilled. However, in common practice the producer is often divided into three zones, ash, fire and coal, instead of four as enumerated above.

As the maintenance of correct temperatures within the producer is vital, and as an excess of steam rapidly reduces temperature, and as all the steam should be introduced that can be decomposed, care should be taken to properly regulate the steam flow. This is best accomplished by automatic means. To accomplish practically a 100% decomposition not only should the correct steam flow be admitted, but the temperature of this zone should be held at 2000° Fahr. The annular type of steam blower is preferable to the old jet type, owing to the fact that the annular type maintains a correct proportion between the air and steam regardless of the rate of flow.

In calculating gas producer needs it must be borne in mind that gas coal of the best, or even fair quality, cannot always be obtained, and that while gasification may be at the rate of fifteen pounds of good coal per square foot, that with poor coal this rate may be reduced to six or seven pounds. All manufacturers give a rate of gasification that is dependable if the conditions are right, but they will not always be right and a substantial factor of safety must always be provided. Hand poked producers require a better grade of coal than is necessary in either the semi-mechanical or mechanical types, but the same rule holds good in all cases. Low ash and low sulphur with a high content of volatile matter is necessary in a good gas coal. Lumps should be crushed, the coal should be dry, and slack or dust should be avoided. Slack coal is seldom cheap at any price if used in a gas producer. The ordinary hand poked producer measuring 8′ 6″ inside diameter should gasify from 600 to 900 lbs. of coal an hour. By equipping such a producer with devices for stirring and levelling the rate of gasification can be increased fifty or sixty per cent. A late type mechanical producer will gasify 3,000 pounds of coal an hour if the coal is good and the conditions fair, but a very safe basis upon which to figure is 2,000 to 2,400 pounds an hour, as this rate can be maintained even with a high sulphur and high ash coal.

Every type of producer has its use and place. Regardless of the authenticated claims made for mechanical producers there are conditions that are better met with hand poked producers as they cost very much less, seldom get out of order and in good hands will produce an excellent quality of gas. However, they do take up more space than mechanical producers, require a better grade of coal and involve a labor problem that is sometimes quite serious. If the initial investment factor is a serious one, the hand poked producer will serve, and it is always possible to later convert them into more efficient equipment by installing machinery that is now standardized and dependable.

Regardless of the type of producer there should be ample reserve capacity provided. It is impossible to build a producer that will operate without an occasional shutdown and such shutdown may be depended upon to occur when the need is greatest. In the first place the producers should be figured at an average, and not at maximum capacity, and if one mechanical producer is needed, two should be installed. If one, two or three hand poked producers are needed, an extra one should be provided. In large installations there should be an extra producer provided between each battery so that it can be thrown into either com-

*Beeman Engineering Company.

bination when needed. Too much stress cannot be laid upon this point.

Unless the conditions are unusual, gas producers offer the only real substitute for natural gas. We find some oil used, some direct firing and some powdered coal, but for simplicity, durability and comparative cost of heating or melting, gas producers are well ahead of all other systems. While some plants persist in using natural gas even at 35c. per thousand feet, it is questionable if it can be used economically beyond a price of 20c. Other factors may enter into the matter and have such a bearing that the high cost of the natural supply is a secondary consideration, but we can only deal with the general average of conditions. Direct firing is inefficient and a constant temperature cannot be maintained. Where regenerators are used, producers will use about half the coal required for direct firing and the temperature is dependable. Without regenerators producers will average about 1,500 pounds of coal as against 2,000 pounds for direct firing. Oil has fluctuated in price a great deal of late, while coal is fairly well standardized in price. To permit of making a comparison based on local conditions one ton of good coal may be considered equal to four barrels of oil and oil calculated as 85% as efficient as producer gas.

To get all that should be gotten out of a producer installation, buy coal carefully, from dependable sources of supply and insist, if possible, that it come up to analysis, and weigh in your coal to the producers, if practical.

Ascertain the best working pressure of the gas in the main and keep it at that pressure, preferably installing a recorder that will provide a permanent daily record.

Take tests of the producers at least twice daily, using a poker that will reach clear down to the grates and insist that each zone be kept within the limits set by the manufacturer.

Check up the gas quality by frequent analysis, and if under standard, locate and correct the trouble without delay.

Do not consider your plant efficient because there is no complaint by heater or melter. One-third of your gas may be lost up the stack. Smoke does not always mean loss, but it is safe to consider a smokeless stack as indicative of good gas house conditions.

Feed coal uniformly and remove ashes frequently.

The temperature of the gas in the producer tops is a very important item. Cold gas is richer than hot gas, but tends to tar, while hot gas precipitates soot. Use a colder gas with regenerators than without. If your gas does not drop below 1000° or exceed 1350° it will be within permissible limits. To increase the temperature of the gas, thin the fire; to decrease the temperature, increase the burden of fresh fuel and deepen the fire. Hot gas looks brown while cold gas has a bluish cast.

Correct gas pressure varies with conditions. Pressure is usually measured in inches and tenths of inches water column and may run as low as one-tenth inch or as high as 2.5 or 3 inch. Given a uniform flow of gas of even quality, it is not at all difficult to maintain a constant temperature, for, although pressure and temperature do not run parallel, a constant pressure is essential in maintaining a constant temperature. This is best obtained by mechanically and automatically controlling the steam flow.

Long experience in the gas producer field has brought out the fact that, once the prospective customer has definitely determined the type and size of equipment best suited to his needs, he can go to the manufacturers of any of the standard producers with the certainty that their statements can be depended upon and their co-operation be assured. As has been brought out before, with the proper equipment of any standard make, the purchaser cannot but be satisfied with his installation, and the increased economy and efficiency of his plant will be commensurate with the wisdom and correctness of his choice of equipment.

Notable Purchase of Antique Stained Glass

In the New York *Times* of Sunday, March 6, 1921, Asa Steele tells of the sensation recently created in artistic circles by the payment by Raymond Pitcairn of the Pittsburgh Plate Glass Company, of $153,850 for 18 panels of ancient stained glass from the estate of the late Henry C. Lawrence. The principal piece was a panel 30½ inches in height and 31½ inches wide, attributed to the thirteenth century and

ENGLISH 13TH CENTURY FANEL BOUGHT FOR $70,000

showing a half-figure of Christ, with a purple face, yellow crown, a white and purple robe and a yellow mantle. The bidding on this panel started at $5,000 and went up rapidly to $70,000, the winning bid. It was rumored that the collection purchased by Mr. Pitcairn would be installed in the beautiful cathedral of the New Church, the erection of which was begun by the late John Pitcairn at Bryn Athyn, Pa., near his home a short distance from Philadelphia, but later this was denied.

Alloy for Glass Molds

An alloy, patented by Foster Milliken (U. S. 1,310,363) contains copper, 56-64 per cent; nickel, 13-17 per cent; zinc, 10-15 per cent. Resistance to oxidation at high temperatures is claimed, also easy machining qualities.

New Patent Issued on Magnesia-Lime Glasses

Patent No. 1,369,988, covering the use of magnesia-lime glasses particularly for use in the manufacture of incandescent light bulbs, was issued on March 21, 1921, by the United States Patent Office to Eugene C. Sullivan and William C. Taylor, and assigned to the Corning Glass Works, Corning, N. Y. The application for this patent was filed May 3, 1919. The specifications follow:

Among the well known glasses are the silica alkali glasses, containing one or more of the bivalent oxids (lime, zinc, etc.) in order to give them a certain amount of stability. Lime, which is in common use for the purpose indicated, has a tendency to increase the hardness of the glass, so that the lime glass heretofore in use has been harder than is permissible for certain purposes, such for instance as the manufacture of bulbs for incandescent electric lamps. As far as known to us, it was at the time of our invention, the common practice in making incandescent electric lamp bulbs to use lead glasses, as only by the use of such glasses could a co-efficient of expansion be obtained approximately that of platinum (viz., .0000091) which is used for the leading-in wires. Among the properties desirable in such a glass are that it be not too hard to prevent proper working within the furnace, that it have the proper viscosity within the range of the temperatures in which it can be worked in its fabrication, and that it be stable to resist disintegration, both under corrosive influences and under long and repeated heatings. With many glasses the latter result in devitrification. If an attempt be made to reduce the hardness of the ordinary lime glass by the addition of alkali, its co-efficient of expansion is increased beyond limits permissible for the purpose indicated. The problem is thus presented, in using lime or alkaline earth oxids, of obtaining stability by the addition of such oxid and at the same time obtaining a sufficiently soft glass without the addition of so much alkali as will unduly increase the expansivity of the glass. We have discovered that magnesia is better suited to accomplish this result than is lime, magnesia glasses having lower co-efficients of expansion than lime glasses of equal softness, and that by the use either of magnesia as the sole bivalent oxid, or as one of a number of bivalent oxids, when combined with other bivalent oxids in proper proportions, we are enabled to obtain satisfactory expansivity, stability, softness and viscosity. We have discovered that the quantities most efficient in producing softness are of lime and magnesia in equal molecular proportions, although satisfactory results may be obtained with a glass not containing any lime. On the other hand, as the molecular proportion of lime is increased over that of magnesia the glass rapidly increases in hardness, the rise in hardness for magnesia in excess of lime being much slower. While, therefore, to produce minimum hardness it may be desirable to use the magnesia and lime in the theoretical proportion stated, it is obvious that a departure therefrom is possible, if the composition is otherwise varied, as by increasing the alkali contents, whereby an increase in hardness, due to the departure from such equal proportions, may be counteracted. This increase in alkali results in an increase in expansivity, and in this connection it is proper to note that our investigations indicate that the expansion co-efficient factor of magnesia in a magnesia-lime glass is higher than the generally accepted expansivity factor for magnesia.

From the above it will be seen that our invention may be embodied in various glass compositions in which the ratio of magnesia to lime is varied and in which the proportions of other ingredients are also varied in accordance with the end sought.

For purposes of specific illustration the following percentage compositions of glasses falling within the scope of this invention are given, composition I being that of a glass disclosed in our prior application, Sr. No. 151,002, filed Feb. 26, 1917 (this case forming a continuation in part thereof as to such composition):

PERCENTAGE COMPOSITION

	I	II	III	IV	V	VI	VII	VIII	IX
SiO_2	68.9	79.4	79	72	63	74.5	70.7	62	72.5
Na_2O ...	20.3	16.8	17.2	19	22	20.2	20.7	23	22
MgO ...	5.6	1.6	1.6	3.7	6.2	2.6	8.6	15	2.6
CaO	5.2	2.2	2.2	5.3	8.8	2.7	..	..	...
ZnO	..	..	..	..	..	..	..	..	3.1

MOLECULAR FORMULA

SiO_2 100	100	100	100	100	100	100	100	100
Na_2O 28.5	20.5	21	25.5	33.8	26.3	28.4	36	29.4
MgO 12.1	3	3	7.7	14.7	5.22	18.2	36.2	5.4
CaO 8.1	3	3	7.9	15	3.89	...	...	..
ZnO	..	..	..	....	...	...	...	3.2

In considering the above molecular formula attention is directed to the further fact that with silica present in the molecular proportion of 100;

1. The univalent oxid (alkali) varies from 20 to 36.

2. That the bivalent oxid contents (magnesia in compositions VII and VIII, magnesia and lime in compositions I, II, III, IV, and V and magnesia and zinc oxid in composition IX) varies from 6 to 37.

It will be further noted that the molecular ratio of magnesia to other bivalent oxids may vary from infinity, as in formulas VII and VIII, to 98 to 1, as in composition V, and in percentage the magnesia constitutes over 40 per cent of the total bivalent contents in all the compositions.

As illustrating the results obtained by our invention, it may be noted that the hardness of the glass of composition I above given is 670° and its linear expansivity is .0000108; the hardness of the glass of composition II is 694° and its expansivity is .0000087; the hardness of the glass of composition III is 680° and its expansivity is .0000089; the hardness of the glass of composition VII is 682° and its expansivity is .0000102; and the hardness of the glass of composition VIII is 664° and its expansivity is .0000110.

Hardness of a given degree meaning that a thread of the glass 1 mm. in diameter and 23 cm. in length suspended vertically and heated to the temperature of the degree stated through its upper 9 cm. elongates of its own weight at the rate of 1mm. per minute.

As a further specific example of the desirable results flowing from this invention attention is directed to the fact that the glass of composition I has good stability. Thus when cane of this glass is placed in distilled water in a sealed tube

and subjected to the temperature of steam at 90 pounds pressure for 3 hours the amount of alkali dissolved from the glass is only .002 mg. of Na_2O per sq. cm. of glass exposed. It has a relative viscosity of 9 whereas that of equi-molecular lime glass is about 150, relative viscosity being relative weight of load in grams necessary at 620° C. to cause a flow of 1 mm. per minute in a cane of 1 mm. diameter.

The above general properties of our glass render it especially desirable as a material from which to blow incandescent lamp bulbs, it being satisfactorily free from a tendency to crystallization in work and of frosting in the flame, and the glass has been primarily designed with that object in view. It is obvious that our invention will not be avoided by slight variations in proportions, unless such exact proportions are demanded in terms by the claims hereunto appended; or by the addition of small and immaterial quantities of ingredients other than those specified herein. For instance, acidic constituents such as boric oxid or alumina may be present in quantities not exceeding 5 per cent of the total mixture, and likewise in special cases the bivalent oxid, lime, may be replaced by another bivalent oxid such as zinc, as is indicated by composition IX.

It should be noted that the alkali preferably used is sodium, as potash tends to increase the hardness of the glass beyond workable limits.

Heretofore, to our knowledge, magnesia has only been intentionally introduced in those glasses which also contain substantial quantities of boric or phosphoric acids, although lime used in glass making usually contains as impurity some magnesia. We believe, however, that we are the first to discover the beneficial result of magnesia when used without lime, or with limited proportions of lime, as shown above.

In another application filed by us under date of December 16, 1920, Serial No. 431,311, as a continuation in part hereof, we make claims specific to the glass of composition VI of this application and directed to glasses containing aluminia and hence by failure to make such claims in this application, do not abandon the same.

Having thus described our invention, what we claim and desire to secure by Letters Patent is—

1. A glass containing silica, soda and two bivalent oxids in the molecular proportions of 100 of silica to at least 20 of alkali to at least 6 of bivalent oxids.

2. A glass containing silica, soda and the bivalent oxids of lime and magnesia in the molecular proportions of 100 silica to at least 20 of soda, to at least 6 of the bivalent oxids.

3. A glass containing silica, soda and bivalent oxids, in the molecular proportions of 100 of silica to at least 20 of soda, to at least 6 of the bivalent oxids.

4. A glass containing magnesia and having a linear expansion not greater than .000011, and a hardness less than 694° C.

5. A glass substantially free from boric and phosphoric oxids and containing magnesia and lime in the molecular ratio of that of more than 1 to 1.

6. A glass in which the molecular ratios fall within the following limits: silica 100; bivalent oxid content 15 to 36; univalent oxid content 25 to 37, and in which the molecular ratio of univalent oxid contents to bivalent oxid contents is that of more than 1 to 1.

7. A glass containing at least one of the common alkaline earths in which the molecular ratios fall within the following limits: silica 100; alkali oxid 25 to 37; bivalent oxid 15 to 36, and in which the molecular ratio of alkali oxid to alkaline earth oxid is that of more than 1 to 1.

8. A silica glass substantially free from phosphoric oxid and containing at least 4 per cent magnesia (MgO), and not more than 5 per cent of acidic constituents other than SiO_2.

9. A silicate glass containing magnesia and at least one other bivalent oxid and having at least 18 per cent of sodium oxid.

10. A silicate glass containing from 5 per cent to 15 per cent MgO, and over 18 per cent of sodium oxid.

11. A glass containing magnesia and lime and at least 18 per cent of sodium oxid.

12. A glass substantially free from boric and phosphoric oxids, in which the magnesia is a chief bivalent element.

13. As a new article of manufacture, an electric lamp inclosure made of a magnesia-lime glass whose coefficient of linear expansion is not greater than .000011.

14. As a new article of manufacture, an electric lamp inclosure made from magnesia-lime glass in which the magnesia is present in greater molecular ratio than the lime.

15. A glass containing silica, soda, and at least one of the bivalent alkaline earth oxids, in which the molecular ratios fall within the following limits: silica 100, alkali oxid 20 to 36, and bivalent oxid content 6 to 36.

16. A glass containing silica, soda and two bivalent oxids in which the molecular ratios fall within the following limits; silica 100; alkali oxid 20 to 36, and bivalent oxid content 6 to 36.

17. A glass containing silica, soda and bivalent oxids of lime and magnesia in which the molecular ratios fall within the following limits; silica 100; alkali oxid 20 to 36, and bivalent oxid content 6 to 36.

18. A glass containing magnesia and having a linear expansion of .0000087 to .000011 and a hardness of between 664° C. and 694° C.

19. A glass substantially free from boric and phosphoric oxids and containing magnesia and lime in the molecular ratio of that of not less than 1 to 1.

20. A glass containing magnesia and substantially free from boric and phosphoric oxids, the molecular ratio of the magnesia to the total bivalent oxid content being at least 1 to 1.

21. As a new article of manufacture, an electric lamp inclosure made from magnesia-lime glass in which magnesia is present in at least the same molecular ratio as the lime.

22. A glass containing silica, soda, lime and magnesia, in which the magnesia is at least 40 per cent of the combined magnesia and lime contents, and in which the molecular ratios fall within the following limits; silica 100, soda 20 to 37, bivalent oxids of lime and magnesia 6 to 30.

23. A glass containing silica and magnesia, in which the magnesia is at least 40 per cent of the bivalent oxid contents, and in which the molecular ratios fall within these limits: silica 100, soda 20 to 37, and bivalent oxids 6 to 30.

Production of Glass Sand in 1919*

By R. W. STONE

A total of 1,827,409 short tons of glass sand was produced in the United States in 1919, a decrease of 16 per cent from the output in 1918. The average price in 1919 was $1.97 a ton, an increase of 3 cents over that of 1918. The total value of all glass sand produced in 1919 was $3,593,371, a loss of nearly 15 per cent as compared with 1918. The accompanying table, showing the production of glass sand in the six principal producing States in 1918 and 1919, brings out the fact that the quantity produced was less in 1919 in each of the States except West Virginia, which made a gain. West Virginia was the only one of the six States, however, in which the average price per ton was less in 1919. Pennsylvania, New Jersey, and Missouri made nominal gains in average price per ton; Illinois increased 22 cents and Ohio 28 cents.

High-grade glass sand in certain localities brought $2.50 to $3 in 1919, but large quantities of low-grade silica sand used for making colored glass bottles and other cheap glass were dug from sand dunes by steam shovel and sold for less than 50 cents a ton; thus the average price was brought down to less than $2 a ton.

The quantity of glass sand reported as produced in Indiana was about 8,000 tons more than the production in Ohio. The Indiana material, however, was mostly of low-grade (dune sand) and was produced and sold at small cost, and the figures cannot well be used in comparison with those of the six leading States in the production of high-grade glass sand.

GLASS SAND PRODUCED IN SIX OF THE LEADING STATES IN 1918 AND 1919.

	1918			1919		
State	Quantity (short tons)	Value	Average price per ton	Quantity (short tons)	Value	Average price per ton
Illinois	760,835	$1,273,804	$1.67	521,286	$886,707	$1.70
Missouri ...	141,062	202,763	1.44	135,683	209,938	1.55
New Jersey.	139,992	242,762	1.73	121,799	225,036	1.85
Ohio	130,359	277,475	2.13	79,580	191,565	2.41
Pennsylvania	450,880	1,065,162	2.36	325,810	797,068	2.45
W. Virginia.	399,936	942,331	2.35	407,918	933,863	2.29

LOCALITIES WHERE GLASS SAND WAS REPORTED AS PRODUCED IN 1919

Arkansas: Guion.
California: Ione and Lake Majella.
Georgia: Lumber City.
Illinois: Millington, Oregon, Ottawa, Utica and Wedron.
Indiana: Michigan City.
Kentucky: Lawton.
Louisiana: Le Blanc.
Maryland: Robinson.
Massachusetts: Cheshire.
Michigan: Rockwood.
Missouri: Crystal City, Festus, Gray Summit, Klondike and Pacific.
New Jersey: Cedarville, Milltown, Pembryn, South River, South Vineland and Williamstown Junction.
Ohio: Austintown, Barberton, Chalfants, Howard, Massillon, and Toboso.
Oklahoma: Hickory and Roff.
Pennsylvania: Derry, Dunbar, Falls Creek, Kennerdell, Lewisston, Mapleton, Newton Hamilton, Parish, Ridgeway, St. Marys and Torpedo.
Tennessee: Lagrange.
Texas: Santa Anna.
West Virginia: Berkeley Springs, Great Cacapon, Greer, Imperial, Sturgisson, Terra Alta (Holmes Station), Thayer and West Berkeley.
Wisconsin: Ripon.

*Mineral Resources of the United States, 1919, Part II.

Notes on Glass Cutting*

Several points on which success in cutting glass with a diamond depends are unknown to beginners, and for this reason it may be of interest to emphasize them.

The opinion seems to prevail that every diamond is fitted for glass cutting. Some beginners make repeated efforts to cut glass with a dull diamond. It is an old, established rule in glass cutting that one operation should be sufficient for each cut, a skill which can only be acquired through long practice.

It should be kept in mind that glass can be cut only with a curved side of a diamond. The manner in which the stone is set is therefore of great importance. Even the hardest diamond becomes dull through long usage. For this reason the pressure on the stone must be increased, little by little, after cutting for a long time. If the diamond has become dull it should be taken from the setting and changed to a different position. It then becomes again fit for further use. Each of its several cutting edges may be utilized.

It is a mistake to believe that every diamond can be used for any and every kind of glass. For the cutting of thin glass small stones with sharp edges should be selected. They must be kept at right angles to the glass. For thick glass the use of larger stones which can stand more pressure is advisable.

Good glass cutting requires skill and practice. The following points should be kept in mind: If a new diamond is used, the cutting edge should be located first. This is done by drawing the holder along the rule at varying angles until the diamond is felt to cut, and gives a peculiar sound. Through changes in the pressure it is easy to find the proper amount required to obtain the best results. If these experiments fail, the diamond is of poor quality.

When buying diamonds it is important to notice the method of setting. A diamond is set right if the cutting edge is parallel to the surface, applied against the rule. The radius of the cutting edge should coincide with the axis of the handle. If this is not the case, the mistake may be rectified by changing the method of holding. It is said among glass cutters that the diamond and the cutter must know one another before good results are obtainable. For this reason most of them insist on having their own diamonds.

When curves are cut, the diamond should be held in such a way that the direction of the cutting edge is always along the tangent of the curve. To facilitate this, the diamond is placed in a movable setting which adjusts itself automatically to the rule and in the proper direction. With some practice it is possible to draw straight lines with such a diamond. The simplest curve is the circle. For this a compass is used. There are also special instruments for cutting ovals.

*Diamant, XLII, No. 36, p. 658, Dec., 1920.

The Nomenclature of Glasses

A Report* of a Paper Presented by Dr. J. C. Peddle at a Meeting of the Society of Glass Technology of England, February 16, 1921, at Birmingham University

The essayist began by saying that when he first took up the study of glass he was struck, and even confused, by the loose terminology employed, for, when referring to his materials, he found that the glassmaker often spoke of "manganese" for manganese dioxide, "lead" for red lead oxide, "arsenic" for arsenious oxide, "alkali" for sodium carbonate, etc. Similarly, glass which was colorless he called "white" glass, while that which was actually white in color he termed "opal." As one proceeded further in the study of the industry one came to assimilate these terms in one's own vocabulary, of which they became a part and parcel. The student, however, had also to be catered for, and as a result of these indefinite terms he was apt to become confused, for in discussion or in literature the same glass was often referred to under a variety of names. In his own experience, the essayist said he had known one particular glass in the optical industry to be designated flint, ordinary flint, dense flint, heavy flint, light flint, straight flint, silicate flint, heavy white, lead glass, and alkali lead-silicate. Which of these numerous terms was likely to make one the more readily think of the particular glass entailed? It certainly seemed that there should be some kind of standardization of nomenclature.

There were many ways of classifying glasses, each of which might be useful in the particular circumstances of its application. In the first place, all glasses might be divided into three types, viz.:—(a) transparent, (b) translucent, (c) opaque. Such arbitrary classification, however, conveyed no information as to the actual constituents of the glass, and was accordingly of small scientific value. Similarly, any division of glasses into (a) colorless and (b) colored (including opal), was of little value. Then there were the time-honored classifications of glasses into "crowns" and "flints." Originally the term "crown glass" denoted only sheet glass made by the old bull's-eye method. This type of glass was almost invariably composed of silica, lime and alkali, and so, in process of time, the designation "crown glass" came to mean any glass containing lime, as opposed to lead oxide. "Flint glass" was originally understood to mean a glass that was made in this country (England) containing lead, the silica being introduced through the agency of pebbles and flints obtained from the river beds and ground into powder. Later on, when flints went out of use and sand was substituted, "flint glass" was understood to mean a glass containing lead oxide, as opposed to lime. Today "crown glass" was understood to contain lime, whereas flint glass contained lead. In the essayist's opinion, these two terms, "crown" and "flint," should be adopted without reservation, since they seem to make for simplicity in nomenclature.

Proceeding, Dr. Peddle pointed out that the mere designation of a glass as crown or flint gave but slight information as to its constitution, and so a more comprehensive method had to be sought. He suggested, therefore, a provisional code of rules for the specification of glasses on the basis of their actual constituents. In the optical glass industry this more comprehensive classification seemed to be an insistent necessity. In the past, optical glasses had simply been divided into four main types: crowns, barium crowns, barium flints and flints. The crowns embraced the hard crowns and the boro-silicate crowns; the "barium crowns" contained barium in contradistinction to calcium; the barium flints contained barium as well as lead, and the flints only contained lead, besides the alkali metals, as the basic constituent. As a rule, each optical glass manufacturer subdivided these classes under headings of density. This, however, was a method which entailed overlapping, and resulted in different optical glass firms alluding to the same glass in a variety of terms. He would propose, therefore, that standardization should be effected by subdividing the classes under the heading of refractive index rather than density.

An interesting discussion followed the reading of Dr. Peddle's paper, which was opened by the chairman, who remarked that he thought a distinction should be drawn between terms adopted for the purposes of technical literature and those used in ordinary everyday commerce. Dr. Peddle did not, of course, wish to suggest that the manufacturer of glass beer bottles should specify his glass by a long string of hyphenated names of materials. In the table-glass trade three terms had been in common use for some time, viz., full crystal, demi-crystal and crystal. Full crystal was usually understood to mean a lead-potash glass—potassium-lead would be the designation according to Dr. Peddle's suggestion—containing about 30 per cent of lead. This was recognized in one of the schedules of the Customs Regulations. Demi-crystal was understood to mean the entire type of soda-lead glasses—although, incidentally, there might be no lead in it. Crystal was a type of glass in between the two—a lead-potash glass usually having a lower percentage of lead than the full crystal, with some soda added. These commercial terms, although rather loose, at least denoted quite distinct types of glasses, and for commercial purposes they would perhaps still be considered more or less satisfactory. Between the works manager and the chemist, however, a standardized nomenclature would no doubt be very useful, and it would also tend to prevent a lot of misunderstanding in technical contributions and amongst students of glass technology. The sooner they arrived at some sort of convention, therefore, the better it would be. The Society was, he thought, taking a step in the right direction.

Mr. E. A. Coad-Pryor made the suggestion that either a committee should be appointed to go into the matter and draft out a schedule of proposed terms, or that the matter should be referred to the Glass Research Association.

*The Pottery Gazette and Glass Trade Review, March 1, 1921, p. 415.

Development of the Glass Industry*

By ALEXANDER SILVERMAN†

The review of technical phases of the glass industry for the past year introduces a heterogeneous lot of material. The writer aims to cover some of the most important points in this paper.

Few new materials have been added to the list. The use of selenium and arsenious oxide as decolorizer has been substituted for manganese dioxide in many additional plants because of greater color uniformity with varying furnace conditions. Researches conducted recently indicate that manganese dioxide will not serve well as a decolorizer in very hot furnaces, and that it actually increases the green color under this condition. The use of lepidolite to produce a deeper white color in tank glass has been suggested, and this material is also being used in crystalware to increase resonance. The boro-silicate glass industry for laboratory and cooking ware is on the increase. The time has come when incandescent lamp manufacturers prefer lime glass bulbs, which can be made from tank glass. Not so many years ago it was supposed that only lead glass could be employed. The difference in the cost of the two raw materials lime and litharge, is considerable when one realizes that about one million bulbs are manufactured daily. The necessity for chemical control of raw materials is apparent to a number of manufacturers. The increasing realization of this will insure greater uniformity and result in added economy in manufacture.

FUEL DEVELOPMENT

The shortage of natural gas has resulted in further installation of the gas producer. Careful efficiency studies have been conducted on various types of producers. Chemical control has indicated the proper apportionment of steam and air to coal and plants operating in this way have lowered their fuel bills. In some factories where natural gas is still employed auxiliary oil burners have been installed for emergency use during periods of low gas pressure. This plan has also worked well.

Pyrometric control is on the increase. With the temperature uniform constant results are obtained in furnaces and lehrs.

Through the researches of the American Refractories Association and of individual companies pots and other units manufactured from American clays are standing up well and promise keen competition for articles made of imported clays. It has been found that by applying a higher temperature to pots before introducing them into the furnace and by allowing them to remain in the furnace longer before filling their life is increased materially. Special linings are now placed in pots to offer resistance to corrosion. Mechanically operated stirrers have been devised for optical glass pots.

Furnaces have been redesigned to meet new fuel conditions. The substitution of producer gas for natural gas has necessitated changes so that the height of arch, depth of metal, position and size of ports, etc., would yield the best results. Muffle-type lehrs or ovens for annealing the glass are gradually displacing older ones in which the flame entered the lehr proper. The radiation from the refractory sides and top insures a more uniform heat and results in a saving of fuel.

NEW PLATE MACHINE

The most striking mechanical development is the Libbey-Owens window glass machine. In this process glass is drawn into a sheet directly from the melting tank, rises over rollers where it is softened to change the direction of the sheet from vertical to horizontal, and then passes through the lehrs to the cutting table. The writer understands that one of these machines has been in constant operation for more than seven months, producing over one foot of window glass per minute.

Decorative processes for art purposes are developing rapidly. One no longer knows whether he is buying a table lamp with a bronze base or one of glass so treated that it looks like bronze. Table ware and vases are etched, cut, engraved, gilded, incrusted and enameled in one of our shops to a degree of perfection envied by European decorators. Hand working of colored and fancy glass is on the increase, and this branch of the industry is gradually approaching the beauty and perfection which have made the factories in Nancy and Bohemia famous.

The *Journal of the American Ceramic Society* has just concluded its second year as a monthly. It contains valuable articles and beside going to thousands of ceramists is sent to many manufacturers. The American Ceramic Society created a "glass division" early in 1920. The growth of this section in technologists and manufacturers during the year indicates a healthy interest in the scientific development of glass-making. The latter part of 1920 witnessed the birth of another monthly journal, THE GLASS INDUSTRY, which deals particularly with the practical aspects of glass manufacture. This should fill a long-felt need in the art.

RESEARCH AND TRAINING

There is a real necessity for co-operation of manufacturers with institutions of higher learning to finance research and investigation. Accurate knowledge of many properties of glass and its raw materials is still lacking. As this is of general interest and published results would be available for all, it would seem only correct that manufacturers should co-operate in financing the work.

Dr. W. E. S. Turner, of the Department of Glass Technology of Sheffield University, England, called attention recently to the lack of a course in glass technology in any American university. Such a course is highly desirable, but educational institutions are confronted with other financial problems which prohibit further expansion. Here again, glass manufacturers, the ultimate beneficiaries, could wisely invest money for the training of men for their industry.

The future American supremacy in the art of glass making will depend on mechanical and scientific developments. Why not insure this by making the necessary investments now through the endowment of training and research in our universities?

*New York Journal of Commerce, March 7, 1921.
†Head of the School of Chemistry, University of Pittsburgh.

The Laboratory

By J. B. KRAK

Technical Valuation of Limestone

Limestones are one of the main divisions of stratified rocks and are widely distributed, both geologically and geographically. Their composition varies greatly, from rocks composed almost entirely of carbonate of lime to others which are high in clayey or silicious impurities. The purest form is crystalline calcite or calcspar, which is supposed to be deposited from water solutions. Somewhat less pure are marble and chalk. The commonest form is the bluish-grey limestone which composes whole mountain ranges.

The chief deposits of limestone have been made through the agency of plants and animals, as shells, corals, bones, teeth and other devices for supporting, housing, protecting and arming them. While it is agreed that the larger part of limestone is of organic origin, it is probable that in many cases its formation has been due to concentration from evaporation and to precipitation from water solutions.

Marked variations in composition may at times be found even in a single quarry, while in other cases a limestone formation may show remarkable uniformity of composition over a wide area. For this reason frequent analyses of limestone, used for batch making are desirable. It is absolutely essential that a limestone, of unknown composition, be carefully analyzed for silica, iron oxide, alumina, titanium oxide, calcium and magnesium oxides, carbon dioxide, phosphoric acid, moisture and organic matter. If the percentage of alumina is high, such as is the case in marls, the limestone invariably contains sodium and potassium oxides. For methods of complete analysis of limestone the reader is referred to Bulletin No. 700 of the United States Geological Survey. The following procedures are sufficiently accurate for technical control work, and when the composition of the material is approximately known.

ESTIMATION OF SILICA.—Dissolve a 2.5 gram sample in hydrochloric acid and add a few drops of nitric acid. Boil for some time, filter, ignite and weigh the insoluble residue.

Weight of Insoluble Residue $\times$ 40 = Per Cent SiO_2

ESTIMATIONS OF IRON AND ALUMINUM.—Transfer the filtrate from the insoluble residue to a 250 cubic centimeter flask, dilute the solution to the mark, mix and pipette two portions of 100 cubic centimeters each. To one portion add 5 grams of ammonium chloride and ammonia in slight excess. Heat to boiling, filter the precipitate, ignite and weigh as combined oxides of iron and aluminum. To the other portion add 5 grams of potassium iodide and titrate the iodine, liberated by an equivalent amount of ferric chloride, with N/20 sodium thiosulphate solution.

1 cc. N/20 $Na_2S_2O_3$ = .399 Per Cent Fe_2O_3

The percentage of alumina is found by difference.

ESTIMATION OF CALCIUM CARBONATE.—To the filtrate of the determination of combined oxides add ammonium oxalate; boil, allow to settle and filter the precipitate of calcium oxalate. Wash well with hot water, perforate the filter paper and wash the precipitate back in the beaker. Add 25 cubic centimeters of dilute sulphuric acid (1:1) and about 200 cubic centimeters of water. Heat to about 70° C. and titrate with N/5 permanganate solution.

Reaction: $5CaC_2O_4 + 2\ KMnO_4 + 8H_2SO_4 = 5\ CaSO_4 + K_2SO_4 + 2\ MnSO_4 + 10\ CO_2 + 8\ H_2O$

1 cc. N/5 $KMnO_4$ = 1.001% $CaCO_3$
1 cc. N/5 $KMnO_4$ = .56% CaO
1 cc. N/5 $KMnO_4$ = .44% CO_2

ESTIMATION OF MAGNESIUM CARBONATE.—Concentrate the filtrate from calcium oxalate, make slightly acid, and add a solution of microcosmic salt. Add ammonia until alkaline, and stir until a precipitate begins to form. After 15 minutes add ammonia in excess. Filter, wash with 3% ammonia, ignite and weigh as magnesium pyrophosphate.

Weight of $Mg_2P_2O_7$ $\times$ 75.75 = Per Cent $MgCO_3$
Weight of $Mg_2P_2O_7$ $\times$ 36.23 = Per Cent MgO
Weight of $Mg_2P_2O_7$ $\times$ 39.52 = Per Cent CO_2

ESTIMATION OF MOISTURE AND ORGANIC MATTER.—Transfer a 1 gram sample to a tared platinum crucible and dry in an oven at 105° C. for one hour.

Loss in Weight $\times$ 100 = Per Cent Moisture

Heat the crucible for 30 minutes over a blast lamp and weigh. The loss in weight represents the carbon dioxide plus the organic matter. Deduct the carbon dioxide combined with lime and magnesia. The difference, multiplied by 100 equals the percentage of organic matter present in the limestone.

The interpretation of the analytical results depends on the kind of glass for which the limestone will be used. Material which is pure enough for window glass may be unsuitable for the better grades of glass. Certain quantities of iron, aluminum, manganese and magnesium, which may render a limestone undesirable for the manufacture of window glass may not disqualify it for bottle glass. Yet it is important in all cases that the composition be known, so that adjustments can be made in the quantities of other ingredients of the batch. For window glass the iron contents should not be higher than 0.3%. For the better grades of glass 0.05% is about the limit, depending on the iron contents of the other batch components. The magnesia should be as low as possible for fine glassware. Quantities up to 5% are not objectionable in limestone used for window glass manufacture.

Glass-Grinding Fluid

Turpentine	45 c. cm.
Ether (ethyloxide)	22.5 c. cm.
Camphor gum	31 grams

The above mixture is used with powdered emery for grinding glass. For smoothing edges, a sheet of emery cloth moistened with this solution may be used.

The Glass Industry

Published Monthly
by the
GLASS INDUSTRY PUBLISHING COMPANY, INC.
19 Liberty Street, New York

L. J. KROM.....President
W. S. COOPER.....Vice-Pres.
G. W. COOPER.....Sec'y-Treas.

Subscription Price.....$2.00 a Year
Single Copy.....20 Cents

ADVERTISING RATES ON APPLICATION

Address all communications to
THE GLASS INDUSTRY, 19 Liberty Street, New York
Telephone, John 4046 Cable Address, Glasdustry

CONTENTS

	Page
The Composition of Opaque Glass	81
Milk or Alabaster Glass	84
The Manufacture of Iridescent Glass	85
The Modern Glass Producer	86
Notable Purchase of Antique Stained Glass	87
New Patent Issued on Magnesia-Lime Glass	88
Production of Glass Sand in 1919	90
Notes on Glass Cutting	90
The Nomenclature of Glasses	91
Development of the Glass Industry	92
The Laboratory:	
Technical Valuation of Limestone	93
Glass-Grinding Fluid	93
Editorial:	
The Chemist and the Manufacturer	94
Technical Consultation Service	95
New Books	95
Correspondence	95
Robert L. Frink and His Work	96
Porcelain That Can Be Worked Like Glass	96
Glass Insulators for High Voltages	96
Patents	97
Glass Factory Equipment and Supplies:	
New Fire Polishing Machine	100
The Duplex Mono	101
New Recording Thermometer	101
Foreign Trade News	102
Trade News	103
Inquiries Received	104
Financial Reports of Glass Corporations	105
Monthly Summary of Foreign Commerce of the United States	106
Current Prices of Glass-Making Materials	106
Stock Quotations	106

NEW YORK, APRIL, 1921

The Chemist and the Manufacturer

Why is it that many glass men who are quick to appreciate inventions and discoveries along mechanical lines, and who have profited greatly thereby, are reluctant to concede to the engineer's professional brother, the chemist, his rightful place in the industry? Has the chemist failed to make good?

The practical application of scientific methods of control to batch, furnace or lehr began only a comparatively few years ago. For hundreds of years previously but little change or improvement had taken place in glass-making methods. Workers in the factory used exactly the same rule-of-thumb processes and sometimes the identical tools and equipment that their grandfathers and great-grandfathers used before them. Thanks to the modern chemist and physicist a great deal better knowledge of the properties of and behavior of glass has been gained during the few years that technical men have been at work in this field than in the whole previous history of the art, and many of the lessons learned have been of practical value. The chemist has already to a high degree justified his claims and the future will unquestionably find the industry more and more dependent upon his knowledge.

But prejudice, ignorance and superstition die hard, and it is safe to say that in a few instances at least the recognition of the chemists' value to the manufacturer will not come until a younger generation with more open mind takes over the responsibilities and opportunities of management.

However, the average manufacturer before long will, we believe, recognize in the trend of the industry towards technical control the evidence that any concern which is content to "let well enough alone" and ignore the advice of the technically trained man within a few years will be as hopelessly incapable of competing with more modern organizations as would a steel manufacturer today who tried to conduct his manufacturing operations by rule-of-thumb methods.

New Bulletin

DISSOLVED GASES IN GLASS, by Edward W. Washburn, Frank F. Footitt and Elmer N. Bunting, published as Bulletin No. 118 by the Engineering Experiment Station, University of Illinois, Urbana, Ill., from whom it may be obtained for 20 cents a copy.

The work described in this bulletin was begun in June, 1917, as part of a program of research on some of the problems connected with the manufacture of optical glass. During the process of manufacturing glass, large quantities of gas, mainly carbon dioxide, oxygen and nitrogen, are evolved from the batch. On cooling the glass, these gases remain in solution. Since no actual data were available concerning the nature or amounts of such dissolved gases contained in glass in the finished state, the experiments described in the bulletin were undertaken for the purpose of throwing some light on the question and discovering, if possible, facts that would help in producing glass free from small gas bubbles.

The apparatus developed and used in the experiments is described and illustrated, the procedure explained, and the gas content of three types of commercial glass—a barium flint optical glass, a light flint bulb glass, and a boro-silicate laboratory glass—are given. The significance of dissolved gases in glass is discussed, and a summary of the results of the investigation is appended.

Technical Consultation Service

THE GLASS INDUSTRY invites its readers to refer to this department any problems with which they may be confronted pertaining to raw materials, glass technology, laboratory and factory practice. While making no pretensions to the possession of unbounded knowledge or infallibility THE GLASS INDUSTRY is ready to assist its readers to the best of its ability in solving their problems. Readers who can offer better suggestions are invited to submit them.

Answers to all questions will be made by mail as promptly as possible. The source of all inquiries will be held in strict confidence.

QUESTION 6.—Will you please inform me what is meant by neutral soda? Is it a monohydrate of soda or just a dense soda ash?

ANSWER.—Two compounds of sodium with carbonic acid exist, namely, acid sodium carbonate, commonly called sodium bicarbonate, and neutral sodium carbonate, which is the common soda ash. Both are formed in the Solvay process, described on page 41, Vol. 2, No. 2. These salts may be considered derivatives of the hypothetical carbonic acid. If one hydrogen atom of this acid is replaced by sodium, the bicarbonate is obtained. If both hydrogen atoms are replaced, the neutral soda is formed. Sodium bicarbonate is so called because in it the ratio of carbonic acid to sodium is twice that in the neutral soda.—J. B. K.

QUESTION 7.—What adhesive mixture is used to apply to glass in sand blast etching to prevent the action of the sand upon portions of the glass that are to remain unaffected by the sand blast? I understand a mixture of stearic acid and tallow is used with another factor, possibly rosin, to give it the adhesive qualities. Do you know whether this is the correct combination. If not, can you give me such a combination?

ANSWER.—An adhesive mixture used to protect glass in sand blast etching may be made as follows: Select a high grade, hard glue and place a number of pieces in a large vessel. Cover them with water and allow to stand for 24 hours. The glue takes up water and swells considerably. The process of taking up water is finished when the mass has become transparent. Pour the water from the glue and allow to drain well. Heat the vessel slowly until the glue melts. Add an amount of concentrated acetic acid equal to five per cent of the amount of dry glue used. Mix with a wooden stirrer until the liquid becomes transparent and viscous. To this mixture add finely powdered talc or soapstone. The amount of talc added depends on the viscosity of the glue solution. Enough should be added to obtain a consistency making it possible to transfer the mixture to the glass by means of a brush or pen. About the consistency of an oil paint is correct. The parts of the glass which are to be protected are covered by this mixture. It should be allowed to dry thoroughly. After the sand blasting it can be rinsed off with lukewarm water.

For complicated designs, in which very fine lines occur, a mixture of asphalt and rosin may be used, which is made as follows: High grade asphalt is dissolved in pure oil of turpentine. Allow to stand several days and stir often, to hasten complete solution. Allow the insoluble matter to settle and pour off the supernatant liquor, taking care not to stir up the sediment. Dissolve in this asphalt solution enough finely powdered rosin to obtain a consistency so that it can be used to draw the finest lines on glass, with a brush or pen. Designs made with this protective coating should be dry in about thirty minutes, but it is best not to apply the sand blast until after 24 hours. The coating can be removed with oil of turpentine.

We do not know of any mixture in which stearic acid and tallow is used. Can any of our readers supply this information?—J. B. K.

New Books

POPULAR CHEMICAL DICTIONARY, by C. F. Kingzeit, F. I. C., F. C. S. Published by the D. Van Nostrand Company. Size 5 x 8 inches, 368 pages. Price $4.

This book has been written with the object of producing a popular educational work, not only for the professional chemist, but especially for manufacturers, merchants and technical men who are interested in chemistry, technology and pharmacy. The subjects of chemistry are outlined in plain terms and the manufacture of the more important inorganic and organic compounds described. The book contains numerous illustrations of chemical apparatus.

DICTIONARY OF CHEMICAL TERMS, by James F. Couch, chemist Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C. Published by the D. Van Nostrand Company. Size, 4¾ x 6¾ inches, 204 pages. Price $2.50.

Within a small volume this book contains practically all chemical, and a number of botanical terms used at the present time, with a concise and lucid explanation of their meaning. No other book covers quite the same field as this, and for years there has been a demand for a compilation such as it presents. The intense specialization of chemists during the last decades has made it impossible to keep in touch with developments in all lines of chemical activity and a considerable number of terms are constantly being created, the exact meaning of which is unknown to even the best informed.

The book itself is of convenient size and of good typographical makeup. It deserves a place in every library and laboratory.

Correspondence

To the Editor of THE GLASS INDUSTRY:

Referring to yours with clipping [stating that operations have begun] would say that the Ouachita Valley Glass Company has just completed the installation of a glass factory to produce bottles and food containers. It is equipped with modern tank and is supplied with eight O'Neill semi-automatic machines. This company is the owner of its own plant, power house and all the equipment and about 30 acres of land besides. It has not commenced operations and has no orders booked, and for that reason is not beginning to produce glass. There is a railroad on either side of the plant. One which is connected by the switch for loading and unloading purposes, and the company has a lease from the railroad company on the opposite side for a switch for loading and unloading purposes, which switch will be completed by the first of September.

Our equipment is complete. We are not in the market for any supplies except raw material. We have 120 tons of cullet in the furnace. We have 180 tons of glass sand in the mixing room. We have the chemicals necessary to begin operation of the plant. This company is in no way responsible for the publication of the clipping attached to your letter, and is not responsible for the publication of any of the many things that are being said about our plant in glass journals and other papers. We have never inspired a single publication with reference to ourselves. We have never made a financial statement to either Bradstreet or Dun or any other credit reporting association. We have paid the money for our equipment and have not asked credit for any of it.

OUACHITA VALLEY GLASS COMPANY.
By Theodore Shockney, General Manager.

April 1, 1921.

Robert L. Frink and His Work

Robert L. Frink requires no introduction to the majority of our readers, as he is generally accredited with being one of the best practical and technical experts in the glass industry of the present day. No doubt this reputation has been acquired by his continued interest in, and study of, the chemistry and problems relating to glass since his boyhood. It was as early as 1891 that he conceived the idea of making sheet and tubular glass by mechanical methods. However, as has so often been the case with young inventors, he was unable to command the capital for demonstrating the practicability of his conceptions. In 1899 through the courtesy and assistance of some financial men, the feasibility of his ideas was demonstrated in a small way, and in 1900 patents were applied for on some of his devices. These were assigned to a company which had been formed for exploitation purposes, but the early experiments were not conducted to a final conclusion on account of insufficient finances and, therefore, had to be abandoned.

ROBERT L. FRINK,
Director of Research, British
Glass Research Association.

In 1902 Mr. Frink made a tour of Germany and Austria for the purpose of investigating methods and apparatus used in producing pure chemical reagents, and the making of certain kinds of glass and porcelain ware used in the chemical industry.

Upon his return to the States he became associated with the American Window Glass Company as chief of their investigation and research department, and during his engagement with them took an active part in the commercial development of what is known as the Lubbers cylinder window glass machine, investing therein many of his own ideas.

In 1907 the Frink Laboratories were opened in Cleveland, Ohio, for the purpose of research in glass, and Mr. Frink was engaged as consulting engineer and assistant in the prosecution of patents by various prominent manufacturers. In 1908 he also organized The Frink Pyrometer Company and undertook the manufacture of the first suspension type of thermo-electric pyrometers produced in America from a commercial standpoint.

About this time he also became associated with The Columbus Glass Company of Lancaster, Ohio, for the purpose of demonstrating and exploiting the "Frink" cylinder window glass machines, and these were placed in commercial operation during 1911. Mr. Frink is the patentee of numerous inventions covering apparatus and methods for the mechanical production of glass.

In 1912 Mr. Frink again resumed his consulting and research work, and devoted considerable time to the study of optical glass, developing furnaces for the making of same, and studying particularly the optical and physical properties of glass, such as refractive index, dispersion, density, surface tension, viscosity, elasticity, expansibility, devitrification and crystallization, eutectics, dielectrics, and other physical and chemical properties. During this time he also developed methods and means for determining the stress existing in glass. Considerable time was also devoted to the study of electric light bulbs, and food and chemical containers, and he was engaged by the principal manufacturers of this type of ware, making improvements in furnace designs and control, mechanical manipulation, and carriage of glassware. In fact during the period of 1912-1920 he was engaged in nearly all branches of glass and ceramic industries, conducting fundamental and productive research, the results of which determined the policy of several of the largest manufacturers in the remodeling and operation of their factories.

During 1919, while conducting some investigations in England and on the Continent, he was nominated and elected for the post of Director of Research by the British Glass Research Association. He accepted the honor extended and assumed official duties about March, 1920, and is still serving the British glass industry in this capacity.

Mr. Frink's endeavors are probably best characterized in the toast tendered him by his present associates at a recent dinner given in his honer, to wit:

> "He never could leave an accepted formula alone. His mind was like some insatiable corrosive, that ate into all the hidden irregularities and plastered weaknesses of accepted theories, and bit its way through every plausibility of appearance."

Porcelain That Can Be Worked Like Glass

It is well known both to the physicist and to the manufacturer, that glass and porcelain behave very differently upon heating. While vessels of porcelain easily crack and burst and in consequence of this are not capable of taking a secondary alteration of form, most varieties of glass can be softened by heat, and then bent, extended, or blown into the form desired. It is this quality of glass which is so useful to chemists and physicists in the laboratory and this is why glass is so greatly preferred to ordinary porcelain for the making of chemical and physical apparatus.

We learn from *Die Naturwissenschaften* (Berlin) that a Bavarian firm has lately succeeded in producing porcelain vessels which are highly resistant to changes of temperature. For the solution of this problem it was necessary to produce a glaze having exactly the same co-efficient of expansion as the mass of porcelain itself. In this way it was possible to obtain porcelain vessels highly resistant both to temperature and to fracture, since the cracking and bursting of porcelain apparatus at abrupt changes of temperature is usually due to the creation of strains between the glaze and the mass as a result of unequal co-efficients of expansion of the two materials. These new porcelain vessels, on the contrary, can even have holes fused in their walls by an oxyhydrogen blow pipe without cracking. Moreover, separate pieces of porcelain can be fused together exactly like glass, so that a porcelain tube, for example, can be fused into the wall of a dish. Finally, this new porcelain can be softened and blown like glass. These qualities seem to assure it a wide usefulness.—*Scientific American.*

Glass Insulators for High Voltages

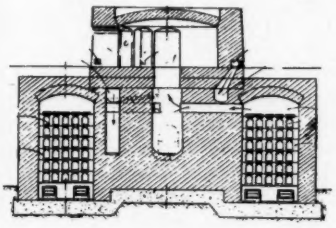
Tests with glass insulators have been in progress in Switzerland for several years, and numbers of these insulators have been used in France and the United States for potentials up to 50,000 volts. The principal application for glass insulators is, however, up to 25,000 volts. Such failures as have occurred with glass insulators have been due principally to internal stresses which cause cracking when the insulator is subjected to heavy mechanical stress or sudden change of temperature. The occurrence of such failure has been made less frequent by the use of improved material and better annealing. As for the puncture strength, it is higher than that of glazed, hard porcelain. The glass used in Switzerland is clear and transparent, hence the absorption of solar heat is less than in the dark green glass hitherto employed. —*Pottery Gazette and Glass Trade Review.*

Patents

RECENT INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Crucible Smelting-Furnace. U. S. 1,365,204. January 11, 1921. Charles M. Stein, of Paris, France, assignor to Societe Anonyme des Appareils de manutention et fours Stein, of Paris, France, a corporation of France.

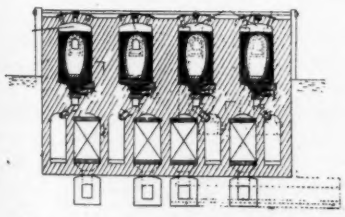
This invention has for its object a crucible furnace with or without covers or lids and particularly suited for the melting of glass or crystal.



This furnace is heated by a central burner opening into the floor of the crucible chamber and is provided with regenerators for the secondary air which supports combustion. The flames after having filled the crucible chamber, descend through the openings in the bases of the columns to the annular collectors which conduct them to regenerators placed outside the walls of the crucible chamber.

These regenerators are traversed on the other hand by the air coming in from outside which is reheated and then enters the central burner where it serves as secondary air to support combustion. The central burner, and in like manner the flues are arranged in glass pits which allow the glass to run away outside the walls of the furnace so as to avoid the choking up of the passages by the glass escaping from the crucibles if these are cracked or broken.

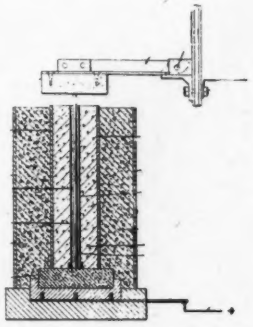
Glass Pot Furnace. U. S. 1,369,453. February 22, 1921. Maurice Mathy, of Liège, Belgium. This invention has for its object to provide an improved crucible furnace or oven for glass making, heated by flameless combustion. Each crucible is placed in a separate chamber and is surrounded with the refractory porous material necessary for carrying into effect this system of heating. These crucible chambers are arranged in two rows along the two longer sides of the furnace or oven. The crucibles are placed in chambers in two series of four each. Under each chamber there are provided air ducts and gas ducts. The gas is supplied through an external duct. The air is supplied from a regenerator. This regenerator may be of any suitable type. The air enters therein through a pipe coming from the duct. It is heated by gases of combustion drawn from the upper part of the chamber by means of a flue. After having passed through the regenerator the gases of combustion pass through a vertical flue into the duct that conveys them to the chimney.



In the case of an accidental breakage of a crucible the mass of molten glass which it contains flows through these cavities, then through the apertures, and passes into the aid duct. This duct communicates through a special passage with the glass hole. This passage is closed by a thin plate of fusible alloy. Immediately the mass of molten glass enters this passage, this plate melts, and the mass of molten glass is able to escape freely into the glass-hole, whence it is removed through an aperture.

Process of Producing Articles of Quartz Glass. U. S. 1,368,990 February 15, 1921. John Scharl, of New York, N. Y., assignor to General Ceramics Company, of Jersey City, New Jersey, a corporation of New Jersey.

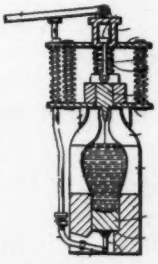
This invention relates to processes of producing articles of quartz glass and is directed particularly to improvements in the well-known process of reducing the quartz to plasticity in an electric resistance furnace with a resistance core and then blowing the plastic mass into molds.



A great difficulty that has been experienced with this process arises from the fact that a comparatively high temperature is required to reduce the silica to plasticity. It has been found that at the temperature required for this purpose gas is given off from the carbon or graphite core. This gas diffuses through the plastic mass of quartz and the finished article molded therefrom is consequently unclean and not homogeneous.

The main object of the invention is to provide a process of the character described in which the gas formed on the resistance core is prevented from diffusing into the plastic quartz mass. A further object of the invention is to provide a process whereby an externally glazed product may be produced without necessitating separate treatment of the plastic mass of quartz in a separate furnace.

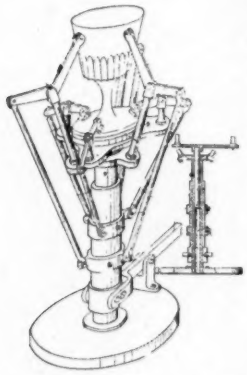
Glass-Forming Machine. U. S. 1,369,679. February 22, 1921. Clyde R. Lott, of Washington, District of Columbia, assignor to the Guardian Trust and Savings Bank of Toledo, of Toledo, Ohio. This invention relates to molds for glass forming machines, and means for working and shaping plastic glass in the molds. An object of the invention is to provide improved means for forming the neck of a bottle or other article in the mold, especially in forming long necked ware. The mold as shown in the accompanying illustration comprises a body portion, a neck mold and a movable bottom which rests in its lowest position against a shoulder formed in the opening of the mold in which the bottom is movable. After a charge of glass is introduced into the blank mold and the neck mold is brought into position thereover, the head is lowered onto the neck mold by a downward movement of the arm. A continued downward movement of the arm forces the rod downward through the plate, compressing the spring and operating through a lever to move the mold bottom upward. The glass is thereby forced upward into the neck mold when the plunger moves downward and the plunger core enters the neck mold, whereby to insure that the molten glass will fill the neck of the mold. The piston and cylinder connection between the mold and the operating arm permits a considerable degree of movement of such arm before the plunger comes into operation.



The construction herein shown is well adapted for making long necked ware as the upward movement of the mold bottom insures the glass being forced upward into the neck mold in

sufficient volume and with sufficient pressure to insure the proper formation of the neck of the bottle. The body mold may be made in horizontally separable sections which are separated after the bottle neck has been formed, leaving the blank suspended from the neck mold for further treatment, as set forth in the co-pending application.

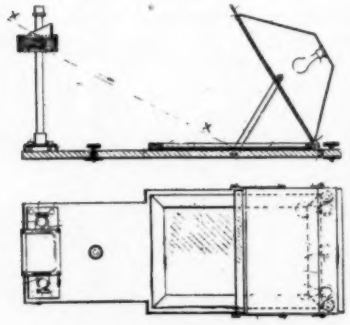
Vise for Holding Glasses. U. S. 1,369,454. February 22, 1921. Maurice Mathy of Liège, Belgium. This invention relates to vises adapted for holding glasses and so forth while being cut or otherwise operated upon and which exert the necessary holding pressure upon the glass by means of two sets of arms operated simultaneously. One of the sets of arms acts upon the foot of the glass so as to press it against a supporting plate, while the other set of arms acts upon the upper part of the glass.



The vise forming the subject of this invention differs from vises of the same type by its simplified construction and operation.

According to the present invention the vise comprises a sleeve slidably mounted on a stationary column, carrying an adjustable supporting plate, and by its movement operating the said sets of arms; one set of arms is pivotally mounted on the supporting plate and is capable of adjustment relatively to the stationary column, and the other set of arms is pivotally mounted on this column. The positions of the joints of connection to the sleeve of the connecting rods for operating the different arms may be adjusted also. All these adjustments can be effected by means of set screws.

Scleroscope for Testing the Hardness or Strain in Glass Due to Insufficient Annealing. U. S. 1,370,738. March 8, 1921. Claude M. Garland, of Chicago, Illinois. The objects of this invention are new and useful improvements in scleroscopes for testing the hardness or strain in glass due to insufficient annealing.

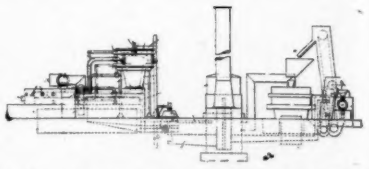


The temperature of the ware is gradually reduced from a temperature of about 1100° F. as it travels through the annealing ovens, which are maintained at a given temperature gradient throughout their length. If by accident the temperature gradient in the annealing oven is disturbed, the glass may be either under or over annealed. Over annealing does no injury to the ware. It, however, means that the ware remains in the oven for a longer period of time than is necessary which consequently cuts down the capacity of the oven and wastes fuel. If the glass is under annealed, however, it is left in a condition which is termed "hard" or "strained." In this condition the glass is liable to break at any time. A scratch on the surface or a change in temperature may start this breakage.

This invention has for its purpose the production of an instrument called a scleroscope which will show by inspection when any transparent glass object has been under annealed or is hard. This is accomplished through the use of a beam of polarized light which is passed through the glass to be examined.

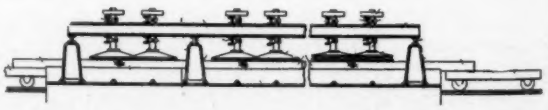
Method and Apparatus for the Manufacture of Glass. U. S. 1,371,084. March 8, 1921. Alexander Ferguson, of Scorrier, England, assignor to Francis William Passmore, of London, England. This invention has for its object to manufacture glass in such manner that not only great economy in the fuel necessary for attaining the requisite temperature is obtained but also the better production of glass of an improved character.

For the purposes of this invention a melting chamber is employed, which has before been proposed for use in connection with the recovery of volatile metals from refractory minerals, combined with a glass-making tank which may also be of a kind which has before been employed, in glass making. Therefore my present invention consists neither in the principle of the structure of such furnace, broadly considered, or in itself alone nor in the structure of the tank itself, but in the combination of the two in the one plant, their conjoint operation to provide an improved process of making glass. The mixture of gas, with the requisite quantity of air by the combustion of which mixture the heat for melting the glass-making materials is obtained, is admitted to, and burnt in, the enlarged upper part of the aforesaid melting chamber, which, as in the case of the aforesaid furnace, decreases downward in cross-sectional area and is preferably of trumpet-, or funnel-, shape, with curved walls and with a dome-shaped top through which the glass-making materials are passed, the said mixture of gas and air on ignition and combustion being forcibly injected under the requisite pressure, so that the gases due to combustion pass in a tangential direction and impart a whirling motion to the particles of the glass-making materials which are thus distributed in the large space beneath the said top and subjected very efficiently to the temperature due to the expanding gases. The distribution of glass-making materials in the expanding gases permits the particles having affinity for each other to readily combine, the slag, or glass, formed passing, under centrifugal force, onto and afterward down, the inwardly curved, or inclined, walls of the melting chamber, and thence into the aforesaid lower portion, or tank, with which in the combination according to my invention the lower contracted end of the melting chamber communicates, the combustion gases also passing from the melting chamber, downward into the said lower portion, or tank, to refine and finish (or assist in refining and finishing) the glass which has passed from the melting chamber, or tank, above.



The molten glass thus refined and finished can flow from the said lower portion, or tank, to the usual, or any suitable, working holes, or compartments, according to the way in which the glass is to be worked.

Apparatus for Grinding or Polishing Plate-Glass. U. S. 1,370,246. March 1, 1921. Frederic Barnes Waldron, of Prescot, England, assignor to Pilkington Brothers Limited, of St. Helens, England. This invention relates to apparatus for grinding or polishing plate glass and has for its object to provide apparatus wherein labor, power and abrasive can be utilized more efficiently than has heretofore been possible with apparatus of other construction.



In early forms of grinding and polishing apparatus, the glass was laid on a rectangular table, and reciprocating rubbers, fed with abrasive, were pressed on the glass and acted to grind, smooth and polish it, either the rubbers or the table being given

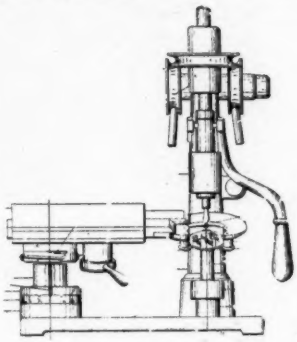
a movement at right angles to the reciprocating movement so that the whole surface of the glass was uniformly acted on.

The present invention among other features combines the advantages of the rectangular form of table employed in the early forms of apparatus with the rotary motion employed in the later forms.

The whole process of grinding or polishing a side of glass is continuous and does not involve the interruption of operation for change of abrasive as in other methods since the apparatus, without stoppage, permits of the effective removal of each grade of abrasive before the glass reaches that stage at which it is operated on by the next finer grade.

The rectangular shape of the tables avoids the necessity for filling the segmental spaces, as is necessary with the usual circular table, with small pieces of glass which are useless commercially and require power for grinding and labor in laying, and, further, as the glass is not subjected to centrifugal force it is more easy to attach it to the table. At the same time, the advantages of the rotary motion of the circular tables are secured by the rotary disk runners and enables high powers and speeds to be employed.

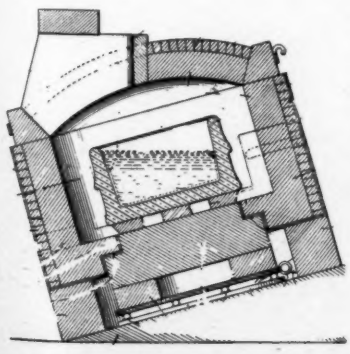
Lens-Drill. U. S. 1,370,035. March 1, 1921. Jeremiah Moffitt, of Southbridge, Massachusetts, assignor to American Optical Company, of Southbridge, Massachusetts. This invention relates to improvements in drills and has particular reference to an improved construction of drill especially adapted for use in the drilling of ophthalmic lenses.



One of the leading objects of the present invention is the provision of an improved construction in which the lens holder or support may be readily adjusted for decentration purposes and for angular positioning of the lens to bring the portion being drilled normal to the drill.

A further object of the invention is the provision of improved means for automatically securing the lens carriage in desired angularly adjusted position.

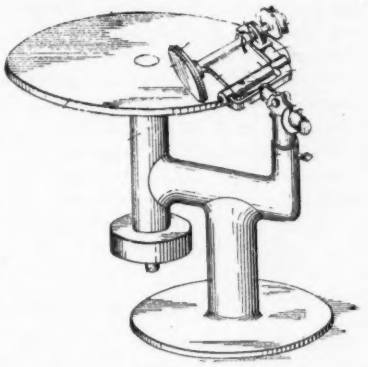
Method of and Apparatus for Removing Striæ from Melted Glass. U. S. 1,370,673. March 8, 1921. Samuel R. Scholes, of Beaver, Lowell W. Nicols and Walter F. Kaufman, of Sewickley, Pennsylvania. This invention relates to a method of removing striæ from melted glass after which it may be gathered or worked out by hand or by semi-automatic or automatic machines or poured out and rolled or cast in any manner whatever.



All glass would be better if it contained no striæ, and all commercial grades of glass would be vastly improved if they contained so few or such fine striæ, that they would be invisible to the unaided eye when viewed from any direction. Striæ are undoubtedly caused by an imperfect mixing of the glass, which prevents it from having a homogeneous, or a uniform chemical composition, and consequently uniform optical properties throughout. If any glass could be homogeneously or perfectly mixed after melting it would be free from striæ. The fundamental problem to be dealt with, in order to avoid these objections, is therefore, very clear, but the physical conditions under which it must be handled render the solution difficult of attainment.

This invention therefore comprises a method of mixing the constituents of molten glass in a pot and preventing the formation of striæ which consists in rotatively moving the pot and its contents while in a position inclined to the horizontal and maintaining all of the glass at the same temperature.

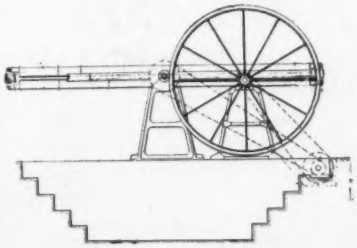
Beveling-Machine. U. S. 1,370,991. March 8, 1921. Perry Okey, of Columbus, Ohio. This invention relates broadly to beveling machines, and has particular reference to beveling machines of the type employed for the purpose of producing inclined edges upon plates formed from glass or other suitable material.



The primary object of the present invention resides in the provision of an improved work supporting structure for use in connection with such machines, whereby a plate will be capable of being maintained in such relation with respect to an abrading element that beveled edges may be produced upon plates of either elliptical, circular or other contours.

Another object of the invention resides in a machine of the character stated wherein the work supporting structure consists essentially of an oscillatory bearing member movably mounted upon a pivot to assume active or inactive positions with respect to an abrading element, the member being formed to rotatably receive a work supporting spindle with which is suitably associated the plate to be ground by the element, the spindle and the pivot axis of the bearing member being located in parallel relation so that the spindle may receive and rotate plates of circular, elliptical or other formations.

Apparatus for Turning Over Sheets of Glass to Facilitate Working on Both Sides of the Sheets. U. S. 1,371,868. March 15, 1921. Georges Henri Léon Debaecker, of Sas-de-Gand, Netherlands, assignor to Société Anonyme des Manufactures des Glaces et Produits Chimiques de Saint-Gobain Chauny & Cirey, of Paris, France, a corporation of France.



This invention relates to a rocking or turning table particularly adapted for use in turning over sheets of glass to enable work to be done on both sides of said sheets. It may also be used with sheets other than glass if desired.

According to the invention the table comprises a frame having two superposed gratings slidably mounted thereon and suitably spaced apart. The lower grating serves to support the glass sheet while the upper grating can be moved to one side of the frame so as to leave the upper face of the glass sheet entirely free, or can be pulled out over the upper face of the glass to hold same while the table is turned to support the glass in its turn when said glass has been turned over. The uppermost grating is then pushed out of the way in its turn to expose the surface of the sheet.

Glass Factory Equipment and Supplies

THE GLASS INDUSTRY will be glad to publish descriptions of new and useful devices, machinery and supplies of interest to the glass manufacturing trade. Most of the information printed in this department comes direct from the manufacturers of the products described.

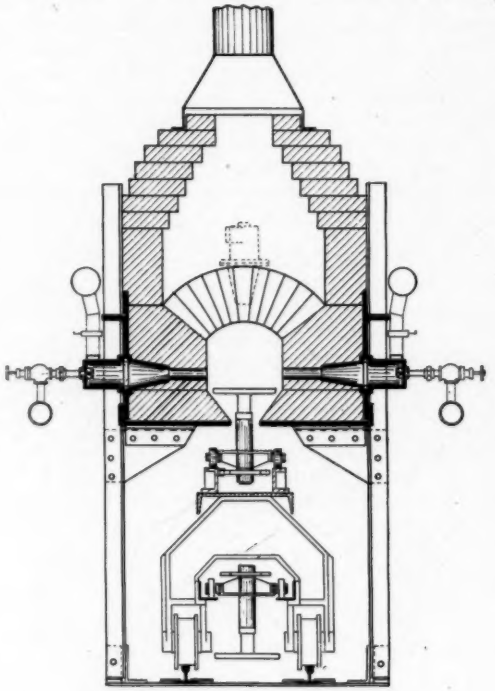
New Fire Polishing Machine

This machine is designed to produce on glass objects the highest possible lustre by heating the surface of the glass to its melting point and allowing it to cool properly before annealing. It handles the work mechanically and is especially adapted to the polishing of tumblers, nappies, bowls, lenses, cooking ware and similar articles. A particular advantage is that ware of varying sizes can be handled successfully without making changes of any kind in the machine.

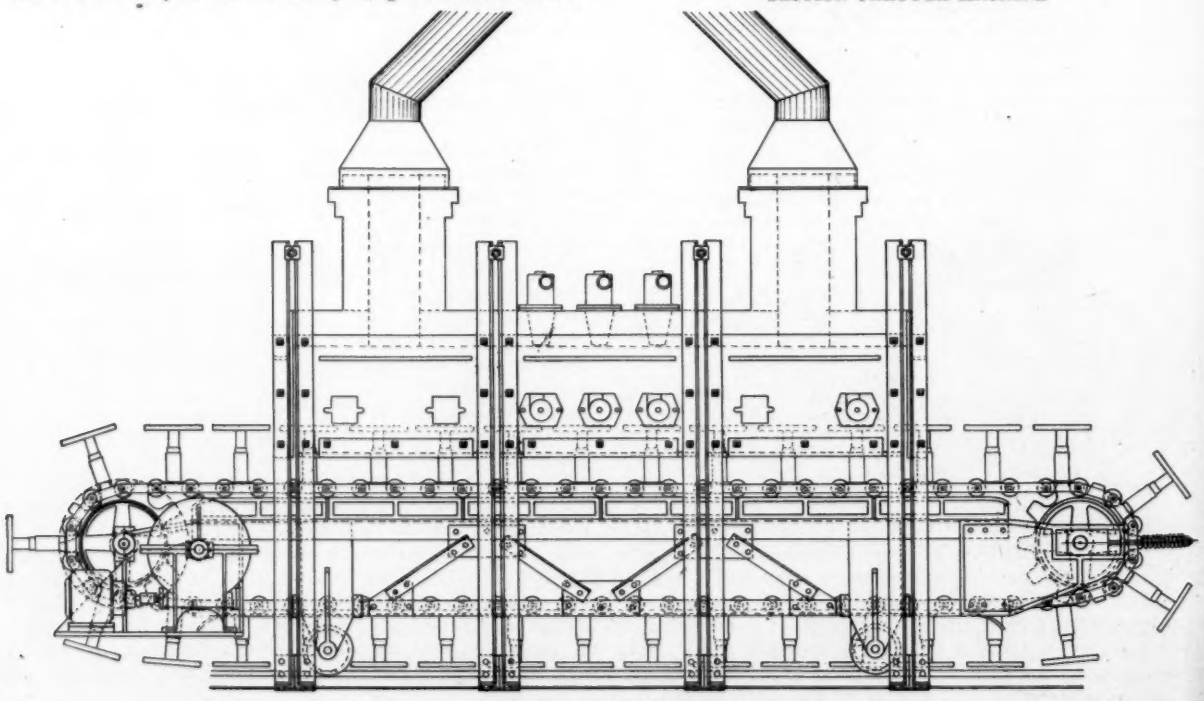
The construction of the machine is clearly shown by the illustrations. The furnace structure is separate from the conveyor carriage, resembling a modern tank furnace in that the sides and roof are carried on steel framework. The whole structure is made substantial and rigid. The furnace is made up of 3-foot sections and can be lengthened or shortened by using a greater or smaller number of the 3-foot units. Fire is supplied at sides and top of the middle section. Burner connections are provided at the sides of the end sections and one of these may be used as a smoke hole to cover ware with soot in cases where such treatment is necessary.

A cast-iron track is bolted to the top of the steel carriage frame and is provided with a large-toothed rack which cannot disengage from the star sprockets that revolve the ware in the fire. Two strands of a special steel link chain with cast-iron rollers have brackets fastened to them which carry the revolving shafts on which the ware is carried and rotated. The chain is driven by a motor mounted on the carriage, through a worm and gear reduction. A take-up at one end of the frame provides means for overcoming any undue slack in the chain caused by expansion or wear. Special requirements for altering the forms of shades, bowls, lenses, etc., can be met by providing carriages of proper lengths and speed of chain.

The machine is provided with a spinning attachment for reforming the ware which is passed through the machine. This is a very simple device which is attached to the delivery end of the conveyor and is provided with a rotating cup for receiving the



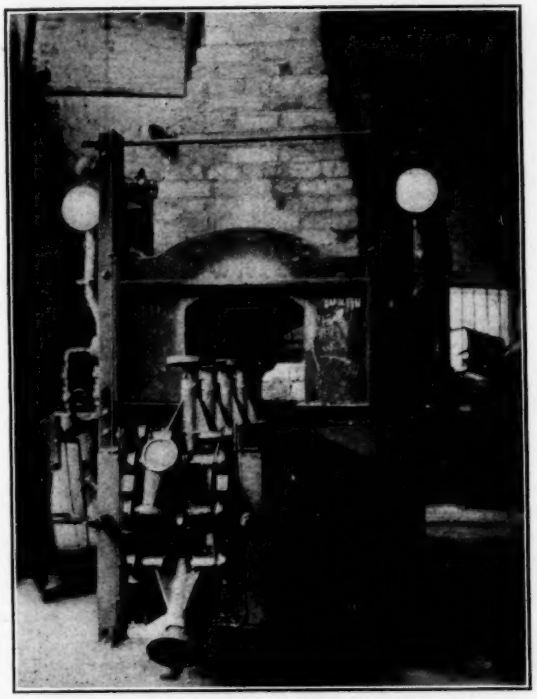
SECTION THROUGH MACHINE



LONGITUDINAL ELEVATION

ware. It is equipped with a treadle kick-out which lifts the ware out of the cup so that it can be carried away.

Four wheels support the machine on tracks extending through the fire-box and an equal distance beyond, which makes it an



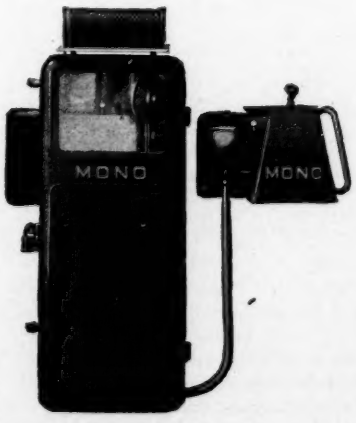
NEW FIRE POLISHING MACHINE

easy matter to remove the machine in its entirety from the furnace when necessity arises for making repairs or cleaning melted glass from furnace walls.

The machine is manufactured and installed by the Amsler-Morton Company, Farmers' Bank Building, Pittsburgh, Pa., glass factory engineers and builders of furnaces, lehrs, gas producers, tile chimneys, lehr conveyors, batch and coal handling and storage plants, steel buildings and other structures.

The Duplex Mono

THE DUPLEX MONO, a new departure in combustion control devices, is described in an illustrated bulletin recently issued by



The Mono Corporation of America, 25 West Broadway, New York City. This device is unique in that it automatically analyzes and records the combined percentages of three combustible gases (CO, CH_4 and H_2) during all such times as any or all of these appear in the flue, while it also produces a continuous accurate record of the percentage of CO_2. Both records are on one and the same chart. This is of a new type, and very clear and easy to read. The bulletin emphasizes the serious losses which frequently occur in boiler plant furnaces on account of the escape of unconsumed combustible gases. This may occur at any time, but happens especially when high CO_2 records are attempted under the guidance of flue gas analyzing instruments recording CO_2 only, even when supplemented by an occasional snap test for CO. With the Duplex Mono as a guide, says the bulletin, the fireman soon learns to regulate his fires and drafts to avoid the escape of combustible gases while holding CO_2 at the highest possible percentage at all times. Should combustible gases appear when the percentage of CO_2 is less than the allowable percentage at which experience with the particular furnace in question has proven it possible to operate under any set of conditions, he knows there is something wrong requiring immediate attention. The plant executive is given a permanent record which gives him the data necessary to compute the degree of efficiency attained in firing, and offers him every opportunity to intelligently select his fuel, make alterations or repairs, and supervise the efforts of the firemen.

New Recording Thermometer

A new thermometer having a number of exclusive and distinctive features, has been placed on the market by the Brown Instrument Company, Wayne Junction, Philadelphia, Pa. The con-

structional advantages of this new thermometer are summed up by the manufacturers, as follows:

The pen arm is completely adjustable with set screws or "set" and tension. The helix is adjustable for calibrating. Every instrument is supplied with a moisture-proof case as standard equipment at no additional cost. The automatic pen release lifts pen automatically when door is opened. The patented chart clips automatically lock the chart when the door is closed. A Seth Thomas clock eight-day movement is attached to front plate, so that clock must, at all times, be in alignment with chart, and can be removed, if necessary, in two minutes.

Other features of the design are the serviceable black enameled case and ring; the open graduations on the chart; the inverted pen arm; the heavy bronze reinforced tubing; the robust bulb, and heavy threaded union connection.

Many charts for ranges from minus 40 degrees F., to plus 1,000 degrees F., are provided as standard equipment.

Deaths

Charles H. Sunderland

CHARLES H. SUNDERLAND, for many years connected with Wing & Evans, Inc., New York City, and treasurer of the firm when he retired from active business about four years ago, died recently at his home in New Rochelle, N. Y.

John Downer Pennock

JOHN DOWNER PENNOCK, general manager of the Solvay Process Company, Syracuse, N. Y., died on March 11, at the age of 61 years. Mr. Pennock was a native of Vermont and a graduate of Harvard University. Shortly after graduating in 1883 he became connected with the Solvay Process Company as chemist and later was appointed chief chemist and eventually general manager. As a chemist he had a notable reputation. He was active and prominent in many scientific societies, commercial organizations and clubs. In 1903 he was appointed by Secretary of State John Hay to represent the United States at the International Congress of Applied Chemistry at Berlin. Mr. Pennock was married in 1890 to Miss Una Bagg, who survives him, as do a son, three daughters and three sisters.

Jacob Hasslacher

Jacob Hasslacher, well known in chemical circles, died at his home in New York City on March 15, 1921, in his sixty-ninth year.

Mr. Hasslacher was born in Ems-on-the-Lahn, Germany, in 1852, the son of Mr. and Mrs. George Hasslacher. He received his elementary education at the public schools at Ems and the Gymnasium at Hadamar, a collegiate institution, from which he was graduated in 1872.

For six years he was connected with the German Gold & Silver Refinery at Frankfurt-on-the-Main. Mr. Hasslacher came to New York in 1884 and with Franz Roessler established the firm of Roessler & Hasslacher, manufacturing and importing chemists, and in 1889 the co-partnership was incorporated under the name of The Roessler & Hasslacher Chemical Company. Mr. Hasslacher was the leading factor in the formation and subsequent development of the Niagara Electro Chemical Company, the Perth Amboy Chemical Works, and in other enterprises in which the company is interested. After many years of active administration of these concerns, he was, on account of ill health, compelled to retire from active participation about a year ago.

Mr. Hasslacher was a member of many organizations, among which were The American Chemical Society, Society of Chemical Industry, American Electrochemical Society, American Association for the Advancement of Science, New York State Forestry Association, Metropolitan Museum of Art, American Museum of Natural History.

Mr. Hasslacher is survived by his widow, two sons and four daughters.

THE NATIONAL GLASS CONTAINER TRAFFIC ASSOCIATION, in its March, 1921, Bulletin, announces the suspension of previously announced increases in commodity rates to lower Mississippi points, calls attention to new bulk loading rules affecting partitions in cars and gives other important traffic news. A. W. Sherwood, Alton, Ill., is chairman of the association, and J. M. Worstall, Kearns-Gorsuch Bottle Company, Zanesville, O., is secretary and treasurer.

Australia imported glass and glassware valued at £636,000 during the year ending June, 1920. Press reports state that consignments of cheap glassware arriving in Australia recently from Austria caused a drop of over 50% in prices.

Foreign Trade News

An opportunity for the establishment of a glass factory at Guatemala City to supply the needs of Central America for bottles and other articles required by breweries, dairies and other users of glassware is reported by the United States vice-consul at Guatemala City, who states that suitable facilitities for the importation of such ware are lacking.

Glass Bottles for India

Possibilities for the sale of glass bottles in India have come to the attention of Consul Dawson. The principal users of bottles in Madras are the soda-water manufacturers and the few breweries. The former use a self-closing bottle which has a small glass ball in the neck. A list of aerated-water manufacturers in India can be obtained from the Far Eastern Division upon request.

British Glass Exports

Exports of glass bottles during February, 1921, amounted to 38,219 gross, or 3,122 gross less than in January, 1921, and 36,779 gross less than in February, 1913.

Exports of all other manufactures of glass during February, 1921, amounted to 29,873 cwts., or 24,136 cwts. less than in January, 1921, and 37,587 cwts. less than in February, 1913.

Dull Times in Sweden

The business of the Swedish window glass manufacturers has fallen off badly, due it is said in a recent report of U. S. Commercial Attaché Anderson, of Copenhagen, to Belgian competition. Belgian glass is said to be selling at 50 per cent lower prices than in June, 1920. It is stated that the Swedish glass works produce much more than the country's consumption demands, and that the import during late years has been very large. From April to July, 1920, the imports amounted to 1,870,000 kilos, and during this same period Swedish production reached 2,130,000 kilos. The result of this has been that the Swedish works have found it necessary to store their production during the last few months, so that their stocks are twice as large as normal and are sufficient for four or five months' consumption.

Spanish Tax Law Bars American Trade

That the new Tax Law of Spain is an almost insurmountable barrier to the continuance or development of American business in Spain, is stated by the National Foreign Trade Council in a letter requesting the assistance of the United States Department of State in obtaining the revision of certain sections of this law.

A complicated and onerous tax system peculiarly harmful to American trade with Spain, is in effect. The disastrous effects of this law are already becoming evident. Important American commercial organizations and banking interests have been forced to withdraw their branches from Spain, and many American concerns find it impossible now to do business, even through authorized agents.

British Propose Limitations on Optical Glass

Restrictions on the importation of optical glass and scientific instruments into Great Britain are proposed in a bill which the British Optical Instrument Manufacturers' Association is urging in Parliament. Under its provisions no optical glass or scientific instruments are to be imported for a stated period, probably seven years, except under license, and such licenses will not be granted on goods similar to those made in Great Britain in required quantities and of the required quality. In return for this protection the optical instrument manufacturers will guarantee reasonable prices and submit to government control of profits.

Employment in British Glass Trades

Employment during February was bad, a further decline having occurred as compared with the previous month, which had in turn shown a marked decline from December, 1920, figures. Returns received from firms employing 7,155 workpeople showed that in the week ending 26th February 14 per cent. of these employees were working on the average 16 hours less than full time.

There was a falling off in employment with glass bottle makers in all districts, though at Mexborough it was still reported to be good. Flint glass makers were not affected to the same extent as other sections of the trade, but at Birmingham they were all on short time. Flint glass cutters there reported little change as compared with the previous month, but plate glass bevellers experienced a further decline. All the pressed glass makers on the Tyne and Wear worked short time and employment was slack. With sheet glass flatteners at St. Helen's, however, it was still reported as good.—*The Labour Gazette.*

Foreign Trade Opportunities

Recent issues of the Daily Consular and Trade Reports issued by the Bureau of Foreign and Domestic Commerce, Washington, D. C., list the following items. Further information concerning any of them may be obtained from the Bureau or its district offices by duly registered firms and individuals, by written request giving opportunity number.

Registration in the Importers' Index entitles the registered firm to receive further information concerning items listed in the Daily Commerce Reports. Registration may be obtained by making application to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or to one of the district or cooperative offices located in nearly all of the large cities, and by filling out "form 57." Registered firms receive additional circulars and bulletins of various sorts relating to their particular line of business.

34633—A firm of commercial agents in Australia desires to secure the exclusive representation of manufacturers for the sale of crockery and glassware. References.

34634—A mercantile company in India desires to purchase all kinds of glasses, etc. Quotations should be given c. i. f. Indian port. References.

34542.—A company of manufacturers and importers in India desires to be placed in connection with firms for the importation of glassware, etc. References.

34557.—A manufacturer's representative from Venezuela is in the United States and desires to secure an agency for the sale of glassware, table and window glass, etc. References.

34592.—An American commercial agent who has sales and office connections in France, is in the United States and desires to be placed in communication with firms with a view to securing an agency for the sale of glass bottles. Quotations should be given c. i. f. Havre, France, or f. a. s. New York. References.

New Law Affecting Foreign Patent Applications

The Nolan Bill (H. R. 15662) previously referred to in these columns was passed by the last Congress before adjournment and became a law upon receiving President Wilson's signature. This law was designed to give United States citizens the benefits of the extension of the Berne International Convention under the special Treaty of June 30, 1920, which provided for the filing up to March 31, 1921, of patent applications which are the subject matter of patent applications filed in other convention countries on or after August 1, 1913. The new law puts the United States in a position to take advantage of reciprocal arrangements with other countries for the protection of patentees, and as the number of American inventions affected in foreign countries is believed to be greater than the number of foreign patent applications affected in the United States, American patentees are expected to be the chief beneficiaries of the new law.

Trade News

All Items Verified Unless Otherwise Indicated

W. W. Gillespie, Topeka, Kans., has started business under the name of the GILLESPIE GLASS COMPANY and is installing machinery for glass beveling and silvering at his new shop, 1017 Kansas avenue.

H. N. McEwen, general manager of the LIPPINCOTT GLASS COMPANY, Alexandria, Ind., states that there is no truth in the report that the company has started the construction of a new 10-pot furnace. No extensions are contemplated.

THE HART GLASS MANUFACTURING COMPANY, Dunkirk, Ind., manufacturers of bottles and containers, is constructing three new automatic lehrs to take the place of five lehrs of the old type, which are being dismantled. The new lehrs will each be 65 feet long and 8 feet wide.

THE AMERICAN GLASS PRODUCTS COMPANY, Bellaire, O., has been incorporated with a capital stock of $100,000 by Walter C. Upperman, R. L. Hutchinson, J. A. Hutchinson, M. L. Sonneborn, R. D. Nicholson and H. C. Althar. The company has been operating for some time engraving druggists, hospital and laboratory glassware and cutting and engraving tableware.

THE DI BELLA GLASS COMPANY, Scott Depot, Putnam County, W. Va., was recently incorporated with a capital stock of $10,000, by H. H. Pine, John Di Bella and W. H. Eggleston. The company has taken over the plant of the Di Bella and Sons Glass Works and are installing new tanks and machinery for manufacturing opal glass gas globes, electric shades and rolling pins.

WING & EVANS, INC., 22 William street, New York, sole agents for the Solvay Process Company, announces that the FRED MOLT COMPANY, INC., 30 North Dearborn street, Chicago, Ill., will transact business as its Chicago branch and the territory in the vicinity of Chicago will be in charge of Fred Molt and Lester Gordon.

THE AMERICAN APPARATUS COMPANY, recently formed at Vineland, N. J., will manufacture physiological, biological and chemical glass apparatus. The officers of the new company are: S. A. Giedroyc, president; Warren S. Hood, formerly connected with the Vineland Flint Glass Works, vice-president and general manager; Otto Lind, treasurer and plant manager, and M. A. Hasse, secretary.

THE CRYSTAL SHADE COMPANY, with offices at Wheeling, W. Va., recently leased the factory formerly occupied by the Lucre Glass Company, at Brilliant, O. A. C. Schiffler is president; Harry Simpson, Jr., secretary and treasurer, and Algonall Rowling, general manager. The company expects to use a machine invented by Mr. Rowling for the manufacture of glassware, and about fifty persons will be employed.

THE MEAD GLASS COMPANY has been organized at Shadyside, O., a suburb of Bellaire, and will manufacture light blownware, including tumblers, electric shades, bowls and bottles, using the Wilcox machine for this purpose. The officers of the new company are: T. W. Pearsall, president; C. M. Wyrick, first vice-

president; W. C. Wilcox, second vice-president; W. G. McClain, treasurer, and Thomas S. Swartz, secretary. The new building, which the company is erecting, is now under roof and according to present plans the plant will be placed in operation in July.

The glass factories of New York State showed a larger reduction from January to February, 1921, in the number of workers employed than any other trade except cement and plaster, a decrease of 17 per cent in employment having taken place.

THE SIMPLEX ENGINEERING COMPANY, Washington, Pa., report the receipt recently of a repeat order for five Simplex muffles for 10-ft. wide lehrs to Ball Brothers Glass Company, Muncie, Ind., for whom they installed four muffles over a year ago. They have just finished another repeat order for two muffles for 7-ft. lehrs for the Salem Glass Company, Salem, N. J., who installed two 10-ft. Simplex Muffles last fall, and started work a short time ago on three 8 ft. by 65 ft. continuous extra heavy lehrs with Simplex flat arch muffles at the plant of the Hart Glass Manufacturing Company, Dunkirk, Ind.

The experimental and model works of F. J. Bernard (established 1906) has consolidated with D. Heller, a well known and experienced mechanical engineer, and will continue business under the firm name of BERNARD & HELLER, at their new quarters, 275 Water street, New York.

In addition to model and experimental work they are prepared to do general machining of castings, patterns, production work in quantity, designing and building of automatic labor-saving machinery and tools, also repairing and adjusting of scientific and laboratory instruments and apparatus.

Press reports to the effect that MARSHALL W. GLEASON, president of the Gleason-Tiebout Glass Company, Brooklyn, N. Y., is interested in a movement looking to the possible establishment of the open shop throughout the industrial section of Queens Borough, New York City, are denied by Mr. Gleason who states that his name was appended entirely without his knowledge or consent to a circular letter sent out to the members of the Queens Chamber of Commerce by the Manufacturing Committee of the Chamber for the purpose of ascertaining the consensus of opinion within the Chamber regarding the open shop question. Mr. Gleason never attended a meeting of this committee and was in the South at the time the above mentioned movement was inaugurated. He is decidedly opposed to such a plan being applied to the concern of which he is president and has notified the manufacturing committee that the name of the Gleason-Tiebout Glass Company and his own name is not to be used in connection with this movement.

New Trade Publication

THE REFRACTORIES BOOK, a new publication which contains much interesting information about a great business institution, Laclede-Christy, and Laclede-Christy refractories is really two booklets in one. The first part contains the history of Laclede-Christy, a complete list of their products, information about their clay mines, ceramic laboratory, etc. Part two is devoted entirely to Laclede-Christy fire brick. Its main feature is a complete list of the places where each one of their several brands of brick should be used. A number of pages are devoted to information of a practical value, such as tables of brick sizes, tables of mensuration, temperature charts, directions for laying fire brick, etc. Glass manufacturers who have not already received copies of this interesting and valuable publication may obtain it from J. H. McKelvey, sales manager, Laclede-Christy, St. Louis, Mo.

Big New Plant to Use Libbey-Owens Process

With the recent incorporation of a new company to construct and operate the great new glass factory which is to be erected by United States Window Glass Company interests at Shreveport, La., came the important and significant announcement that the new plant will be operated under license to use the Colburn continuous sheet glass manufacturing process developed by the Libbey-Owens Sheet Glass Company at Charleston, W. Va. The new organization was incorporated in Ohio on March 30, 1921, as THE UNITED STATES SHEET AND WINDOW GLASS COMPANY by Walter R. Jones, Jo L. Keener, Fred C. Rector and others. It is capitalized at $4,000,000. Mr. Jones and Mr. Keener are the principal owners of the United States Window Glass Company, Mr. Jones being president and Mr. Keener, secretary and treasurer. Mr. Jones will also be president of the new company, and Mr. Keener, secretary. H. E. De Vaughn is chief engineer for both concerns.

Shreveport's excellent natural gas supply and the strategic position of the city, near the Panama Canal, making it an attractive location from the exporting point of view, are said to have been the determining factors in the selection of the southern city as the site of the new enterprise. With these natural advantages, with a factory that will be, when completed, the most modern in the world, and with experienced men in control, the outlook for the new company appears to be most promising.

Inquiries Received

Further particulars may be obtained from THE GLASS INDUSTRY

No. 12.—We are in the market for soda ash in quantities.

No. 13.—Kindly send the names of the manufacturers of machines for making tumblers by blowing and pressing combined.

No. 14.—Can you give me the market price of all kinds of peanut butter containers? Please send address of nearest soda ash factory to Seattle, Wash. Please put me in touch with firms manufacturing oil burners for tanks.

No. 15.—We have a foreign inquiry for an electric furnace for melting glass.

No. 16.—Am about to market a hair tonic. Where can I secure glass, china or pottery containers?

No. 17.—Please put me in touch with concerns making plate glass polishing machinery which could be adapted for polishing steel.

No. 18.—We are sending you samples of prescription vials and flat bottom tubes. Kindly put us in touch with manufacturers of automatic machinery (for export) for making such products.

Harbison-Walker Refractories Report

The eighteenth annual statement submitted by the board of directors to the stockholders of the Harbison-Walker Refractories Company on March 7, 1921, shows net earnings of $2,869,995.69 for the year ending December 31, 1920, after making deductions for ordinary repairs, Federal taxes and charging off $849,790.74 for depreciation and the depletion of mineral properties. Dividends to the amount of $495,537.50 were paid on preferred stock and $1,242,049.50 on common. A 50% stock dividend of $9,000,000 was paid to the common stockholders, leaving a surplus at the end of the year of $4,882,917.99. The outlook for the immediate future was referred to by H. W. Croft, chairman of the board, as follows:

"Orders for October, November and December were at the rate of 64%, 42% and 28%, respectively, of our capacity; for the month of January and February, 1921, at the average of 25% of our capacity, and while we are still operating on a 45% basis, this can only continue until such time as we have finished the contracts in hand, when, unless there is an upturn, we will be obliged to still further curtail our output. We might add that as a rule we trail a boom or depression in general business about six months, due to the fact that a large percentage of our business is new construction, which naturally does not begin until a healthy revival of business is well under way, and carries over a corresponding period of time when a depression sets in."

Owens Bottle Company

The following report setting forth the year's business of 1920 of the Owens Bottle Company and its subsidiaries, has been issued by E. D. Libbey and F. L. Geddes, president and secretary, respectively, of the company.

ASSETS

Permanent—Land, buildings, machinery, equipment, etc., depreciated value, $10,753,522.97; gas property plant, leases, wells and equipment, $1,657,874.82; patent rights, licenses, contracts, etc., $3,143,212.54; good will of subsidiary companies, $1,700,000.00.

Current—Cash and short-time treasury certificates, $1,475,294.23; other U. S. government securities (at market price), $786,745.01; notes and accounts receivable, $2,493,113.24; less, allowance for doubtful, etc., $168,246.77, $2,324,866.47; merchandise inventory, $7,209,504.07, $11,796,409.78.

Loans and accounts receivable—Controlled companies, $189,421.29; licensed and other companies, $123,063.07, $312,484.36.

Investments—In controlled companies, $1,759,350.00; in licensed and other companies, $2,799,149.97, $4,558,499.97.

Notes receivable for stock sold to employees—secured, $970,432.66.

Other assets—Outside real estate, miscellaneous notes and accounts receivable, claims, etc., $820,633.14.

Deferred—Prepaid expenses, supplies, etc., $166,406.10; total, $35,879,476.34.

LIABILITIES

Capital stock—Preferred 7% cumulative, authorized, $18,330,100.00; less, unissued, $8,742,600.00; in treasury, $137,300.00, $8,879,900.00, $9,450,200.00.

Common—Authorized, $30,000,000.00; less, unissued, $18,956,550.00; in treasury, $5,875.00, $18,962,425.00, $11,037,575.00, $20,487,775.00.

Interest of minority stockholders in subsidiary companies, $1,275.78.

Current—Accounts payable, $1,063,315.96; customers' credit balances and advance payments, $1,272,851.65; accrued taxes, etc., $155,633.48, $2,491,801.09.

Reserve—or repairs, Federal taxes and contingencies, $2,957,599.26.

Surplus—Appropriated, for gas development, $220,461.19; unappropriated, $9,720,564.02, $9,941,025.21; total, $35,879,476.34.

Attention is directed to the fact that preferred and common dividends amounting to $496,659.75 payable January 1, 1921, were paid to the disbursing agent in December, 1920.

INCOME

Manufacturing profit after deducting material used, labor, royalties, manufacturing expenses and depreciation, $4,343,490.08; Royalties—Controlled companies and Owens factories, $1,549,181.65; licensed companies, $576,432.38, $2,125,614.03; total manufacturing profits and royalties, $6,469,104.11.

Other income—Dividends on stock owned, *$660,157.67; interest earned, $187,182.35; profit on sale of investments, $89,349.20; profit on gas and miscellaneous departments, $294,676.04; miscellaneous income, $88,333.54, $1,319,698.80; total income, $7,788,802.91.

Expenses and other charges—Administrative, selling and general expenses, provision for doubtful accounts, dismantling expenses, obsolescence, etc., $2,143,197.50; profit before providing for Federal taxes and contingencies, $5,645,605.41.

Provision for Federal taxes and contingencies, $1,423,400.00; net profits, $4,222,205.41.

*NOTE—Dividends on stock owned include stock dividends received from licensed companies.

In the net profit as shown above The Charles Boldt Glass Company and The Graham Glass Company of Oklahoma are included only to the extent of the dividends actually received from them. Were we to include the proportion of the profit of these companies applicable to our stock ownership, the net profit would be increased by approximately $182,000.

The physical condition of the company's properties has been maintained and improved, and proper depreciation charges have been made.

A more detailed report of physical conditions and operating developments will be made at the annual meeting of stockholders to be held in Toledo, April 13, 1921.

Pittsburgh Plate Glass Company

The annual report of the board of directors of the Pittsburgh Plate Glass Company for the year 1920 was submitted to the stockholders on March 12, and shows net earnings for the year of $8,595,915.79, after deducting the sum of $2,262,180.01 for depreciation and obsolescence, a reserve of $5,500,000.00 for estimated Federal income and excess profits taxes on 1920 earnings, and a reserve of $4,850,000.00 for possible inventory deflation.

During the year important improvements involving large expenditures were made. The completion of new mechanical equipment and power plant at the Kokomo works doubled its productive capacity. Factory No. 4 at Ford City was greatly improved. The Belgian plant at Courcelles, destroyed by the Germans during the war, is being reconstructed and should be in operation this year. A claim against Germany for reparation has been filed with the Secretary of State at Washington. A large fireproof warehouse was purchased at Minneapolis and similar warehouses built at Omaha and Detroit. The permanent assets of the Columbia Chemical Company, Patton Paint Company, Pitcairn Varnish Company, Corona Chemical Company, Rennous, Kleinle & Co. and the Redwing Linseed Oil Company have been included in the investment account of the Pittsburgh Plate Glass Company. All property of every kind owned by the company and its subsidiaries is clear of all incumbrances. The preferred stock has been retired.

STATEMENT OF ASSETS AND LIABILITIES, DECEMBER 31, 1920.

ASSETS		Assets	Liabilities
Investment		$35,968,524.36	
Merchandise	$9,218,910.92		
Material and working accounts	7,018,286.33		
Bills and accounts receivable	11,561,073.22		
Bonds, sundry	211,547.50		
Bonds, Liberty Loan	502,127.73		
Cash and cash items	2,472,680.48		
Quick assets		30,984,626.18	
Treasury stock		6,894.91	
LIABILITIES			
Capital stock authorized	$37,500,000.00		
Less unissued capital stock	622,400.00		$36,877,600.00
Fractional shares issued			50,240.00
Sundry credits:			
Bills payable	None		
Accounts payable (current)	$3,132,797.82		$3,132,797.82
Insurance fund			261.981.69
Reserve for possible inventory deflation			4,850,000.00
Reserve for estimated federal income and excess profits taxes payable in 1921			5,500,000.00
PROFIT AND LOSS			
Surplus January 1, 1920	$19,491,615.68		
Surplus paid in by paint, varnish, dry color, brush and chemical divisions	804,905.61		
Earnings for year 1920 after above reserves for taxes and inventory deflation	$10,858,095.80		
Less depreciation and obsolescence	2,262,180.01	8,595,915.79	
		$28,892,437.08	
Less common stock and premium issued and paid to retire preferred stock	$197,916.92		
Federal income and excess profits taxes on 1919 profits	2,896,490.22		
Cash dividends	3,355,964.00		
Stock dividends	6,154,640.00	$12,605,011.14	
Balance in surplus account December 31, 1920			16,287,425.94
		$66,960,045.45	$66,960,045.45

MONTHLY SUMMARY OF FOREIGN COMMERCE OF THE UNITED STATES.
Corrected to March 1, 1921.

IMPORTS OF GLASS AND GLASSWARE.

Articles	January 1920 Quantity	January 1920 Value	January 1921 Quantity	January 1921 Value	Seven months ending January 1919 Quantity	1919 Value	1920 Quantity	1920 Value	1921 Quantity	1921 Value
Glass and glassware:										
Bottles, vials, demijohns, carboys, and jars, plain, ordinarily used as containers, empty or filled ....lbs. dut.	643,693	$29,305	372,615	$18,957	1,610,551	$54,484	2,505,057	$123,976	5,679,682	$246,113
Bottles, decanters, and other glassware, cut or ornamented ....dut.	.....	42,308	.....	113,245	.....	95,345	.....	293,210	.....	1,032,964
Optical instruments, including lenses and spectacles ....dut.	.....	56,479	.....	88,723	.....	91,648	.....	291,611	.....	697,901
Sheet and plate glass—										
Cylinder, crown, and common window glass, unpolished ....lbs. dut.	172,583	21,249	1,168,632	86,865	242,492	25,718	831,067	121,738	4,825,698	457,852
Plate glass, cast, polished, unsilvered, sq. ft. dut.	14,377	8,117	335,774	283,848	273	210	18,550	11,172	2,461,697	2,232,658
Plates or disks, rough-cut or unwrought, for optical purposes ....lbs. free	87,964	53,875	95,837	91,063	436,885	211,551	343,118	253,638	605,627	627,083
All other ....dut.	.....	115,879	.....	190,306	.....	192,438	.....	448,002	.....	1,712,384
Total	.....	$327,212	.....	$873,007	.....	$671,394	.....	$1,543,437	.....	$7,006,955

EXPORTS OF GLASS AND GLASSWARE.

Glass and glassware:										
Bottles, demijohns, carboys, and jars	.....	$718,303	.....	$999,022	.....	$1,634,092	.....	$3,727,503	.....	$5,648,637
Chemical glassware	.....	15,041	.....	41,528	.....	111,013	.....	110,058	.....	191,570
Common window glass, boxes (50 sq. ft.).	52,876	337,130	28,231	228,563	422,964	2,626,569	430,257	2,735,665	316,827	2,229,677
Exported to—										
France	.....	.....	4	$36	.....	.....	4,476	$35,058	4	$36
Canada	27,987	$147,767	5,542	42,984	133,650	$690,388	224,998	1,237,445	140,750	911,885
Mexico	906	10,705	3,856	42,312	9,551	74,746	10,177	82,703	24,687	209,617
Cuba	3,157	23,354	1,582	21,806	22,838	150,121	15,806	108,823	29,025	224,832
Argentina	2,484	24,081	2,440	17,205	72,479	497,890	20,000	158,253	23,000	140,020
Brazil	4,004	27,916	2,122	12,066	16,271	105,177	30,097	223,503	17,356	119,942
Chile	2,836	16,246	117	1,333	51,953	358,609	17,805	113,445	7,878	51,323
Uruguay	.....	.....	2,318	14,077	.....	.....	5,615	39,563	13,556	87,616
China	1,900	12,196	1,125	11,029	.....	.....	17,566	146,756	5,132	38,401
Japan	4,580	40,501	26	276	2,598	32,097	12,430	112,190	10,367	84,489
Australia	108	651	1,314	9,881	60,853	349,919	10,136	65,121	6,621	46,287
New Zealand	.....	.....	8	54	6,876	33,528	3,088	19,563	944	9,100
Other countries	4,914	33,713	6,777	55,498	45,895	334,094	58,063	393,242	37,507	306,129
Cut or engraved glassware	.....	$33,672	.....	$37,843	.....	$95,781	.....	$177,385	.....	$256,625
Plate glass, unsilvered ....sq. ft.	462,454	251,367	442,925	316,325	4,544,178	2,672,256	2,747,027	1,551,072	2,084,627	1,591,068
All other	.....	879,916	.....	1,551,308	.....	3,554,470	.....	5,118,103	.....	8,620,939
Total glass, etc.	.....	$2,235,429	.....	$3,174,569	.....	$10,694,181	.....	$13,419,786	.....	$18,538,516

Current Prices of Glass-Making Materials

From quotations furnished by various manufacturers and dealers New York, March 8, 1921

	Carlots.	Less Carlots.
Alumina hydrate ....lb.		.12 – .14
Arsenic trioxide (dense white, 99 per cent....lb.	.08	.08½
Barium carbonate....ton	$65.00	$75.00
Bone ash ....lb.	.05	.05½
Borax ....lb.	.06¾– .07½	.07 – .07½
Borax, fused, any mesh....lb.	.19	.20
Boric acid, fused....lb.	.35	.35
Cadmium sulphide, red or orange ....lb.		1.60
Cadmium sulphide, yellow..lb.		1.60
Cobalt oxide....bbls., lb.		3.00
Cobalt oxide,.... tins, lb.		3.10 –3.25
Copper oxide, red....lb.		.17 – .20
Copper oxide, black....lb.		.23 – .26
Feldspar, 100 mesh....ton	18.00	
Fluorspar, powdered white 90 per cent....ton	55.00	60.00
Kaolin ....ton	25.00	35.00
Kryolite ....lb.		.15
Lead oxide, (red lead, Pb_3O_4)	.09¼	.09½
Litharge (PbO) ....lb.	.08¾	.09
Lime—		
Hydrated ....ton	45.00	
Burnt ....ton	17.00	
Manganese (85% MnO_2)...lb.	.04¼– .06	.04½– .06½
Nickelic oxide (NiO) black—lb.		.35
Nickelous oxide (Ni_2O), green ....lb.		.38
Potassium Carbonate—		
Calcined ....lb.		.09 – .09½
Hydrated ....lb.		12 – .14

Current Prices—(Continued)

	Carlots.	Less Carlots.
Potassium nitrate....lb.	.09¾	.10
Powdered blue....lb.		.30
Salt cake, for glassmakers..ton	28.00 –30.00	
Selenium ....lb.		2.25
Soda Ash, 58% dense (48% basis), bulk ....100 lb.	1.72½	1.82½
bulk, on contract....100 lb.	1.67½	
Sodium nitrate ....lb.	.06	.07
Sodium selenite....lb.		2.25
Sulphur (flowers) ....lb.	.03¼	.03½
Uranium oxide ....lb.		2.25
Zinc oxide (ZnO)....lb.	.09½	.10

Stock Quotations

(Reported by Moore, Leonard & Lynch, Frick Building, Pittsburgh, Pa.)

Pittsburgh Stock Exchange—April 7.

	Bid	Offer	Last	
Am. Window Glass Mach. com...	60	63	62	
Am. Window Glass Mach. pfd....	75	76	76	
Am. Window Glass pfd.....	..	96	96	Odd Lot
Pittsburgh Plate Glass	114	115	114	
U. S. Glass	39	41	40	

Market dull and weak. The noteworthy event of the past month of the Pittsburgh Glass Stocks has been the drop of over 40 points in the American Window Glass Machine Common.

Wheeling Stock Exchange—April 7.

Fostoria Glass Company	107	112	110
Hazel Atlas Glass Company.....	145	147	147
Imperial Glass Company	115	120	120
Central Glass Company	145	150	150

Market dull, but prices firm.

Toledo Stock Exchange—April 7.

Libbey-Owens Sheet Glass com.	111	117	114
Libbey-Owens Sheet Glass pfd...	95	99	97
Owens Bottle Machine com.....	45	48	48
Owens Bottle Machine pfd.....	..	100	..